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The Philippine Agricultural Review

VOL. VIII FIRST QUARTER, 1915 No. 1

SPECIAL ARTICLES

CITRUS FRUITS IN THE PHILIPPINES

By P. J. Wester

BY-PRODUCTS OF SUGAR MANUFACTURE

By C. W. Hines

A QUARTERLY PUBLICATION
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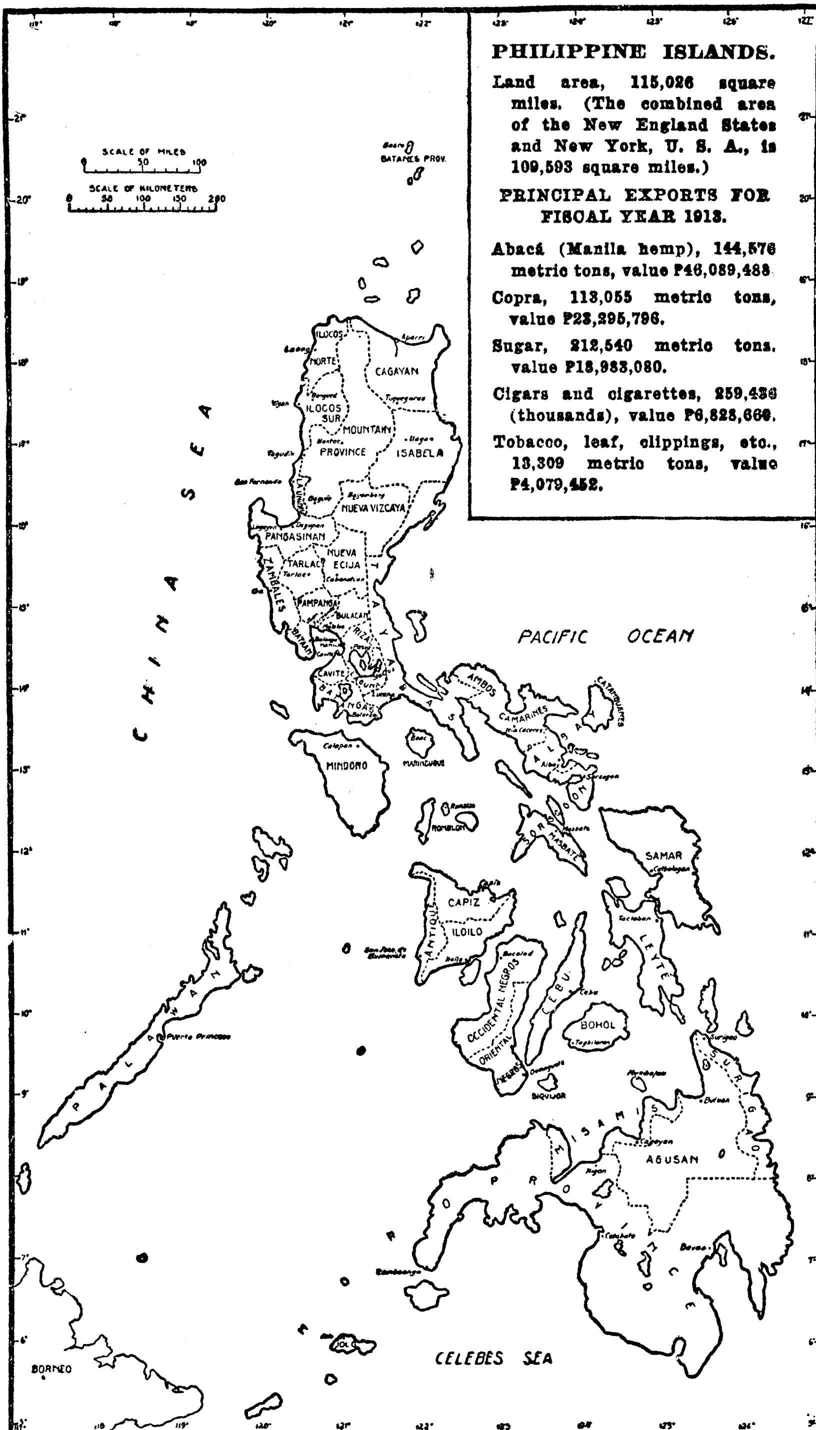
PHILIPPINE ISLANDS.
Land area, 115,026 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR FISCAL YEAR 1913.
Abacá (Manila hemp), 144,576 metric tons, value ₱46,089,488.
Copra, 113,055 metric tons, value ₱23,295,796.
Sugar, 212,540 metric tons. value ₱13,983,080.
Cigars and cigarettes, 259,436 (thousands), value ₱6,828,666.
Tobacco, leaf, clippings, etc., 13,309 metric tons, value ₱4,079,452.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
LA UNION
NUEVA VIZCAYA
PANGASINAN
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
BATAAN
RIZAL
CAVITE
BATANGAS
TAYABAS
CHINA SEA
PACIFIC OCEAN
AMBOS CAMARINES
CATANDUANES
ALBAY
SORSOGON
MINDORO
MARINDUQUE
ROMBLON
MASBATE
SAMAR
CAPIZ
ILOILO
ANTIQUE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
LEYTE
SIQUIJOR
PALAWAN
SURIGAO
MISAMIS
AGUSAN
MORO PROVINCE
JOLO
CELEBES SEA
BORNEO

Plant-propagation shed, Lamao experiment station.

UNIV. OF MICH.

THE PHILIPPINE

Agricultural Review

VOL. VIII FIRST QUARTER, 1915 No. 1

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EDITORIAL.

THE SUGAR INDUSTRY.

It is supposed that the sugar cane (*Saccharum officinarum*) was originally found in India, probably in the region of the Ganges. There is no sugar cane known anywhere to-day in the wild state although there are several species of mammoth grasses closely akin to this plant.

As various portions of the earth's surface were explored and finally settled the sugar industry was extended until to-day one finds it flourishing in practically all tropical countries and many subtropical countries as well. Perhaps the last semi-tropical region to attempt this industry in a commercial way was the State of Arizona, U. S. A., where the desert wastes were turned into flourishing beet and cane fields by the aid of irrigation from the Government storage dam.

During the reign of Napoleon in France trade in the sugars from British and other foreign possessions was destroyed by the war with England but this decline in the cane-sugar trade served only as an impetus to the new beet-sugar industry then being started. In the meantime there was such a dearth of sugar and such a fabulous rise in prices, that attempts were made to secure sugar from various plants and fruits growing in France, such as beets, sorghum, maize, grapes, apples, pears, figs, etc.

At that time the manufacture of a kind of sugar from grapes became quite important so that during the period from 1811 to 1813 considerable quantities of this class of sugar were made. Simultaneously with this new venture the beet root was gaining in importance year by year, especially in France, and to a certain extent as well in other European countries, until after extensive experiments in plant breeding it was learned that the sucrose value of the root could be very much improved. From this work varieties of beets used to-day have evolved which often contain as high as 20 to 25 per cent sucrose. Another obstacle in the way was the bad taste and odor of the low-grade sugars from the beets and the difficulty of making a high-grade sugar. To-day the heavy liming and the carbona-

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tion process give a sugar equal in all respects to the best grade of granulated cane sugar, and one finds a great deal of beet sugar either mixed with cane sugar or marketed alone under the name of cane sugar.

At the present time the beet-sugar industry has become so important that more than eight million tons, or about one-half of all the sugar produced, comes from this source.

There is a greater consumption of sugar each year which necessitates greater production either through larger areas, heavier yields, or its manufacture from other sacchariferous plants. The maximum in both area and yield have by no means been reached, while in recent years a large number of sacchariferous plants have attracted the attention of various investigators throughout the sugar world, and this will in all probability lead to a new source of supply. The most promising of these plants is the sugar palm (*Arenga saccharifera*). Extensive work was conducted on this palm by this Bureau and reported in the May, 1914, number of the PHILIPPINE AGRICULTURAL REVIEW. During the above-mentioned year an entirely new method of juice clarification was elaborated which is applicable to the juices of various other palms as well as to that of the sugar cane.

In Bengal the wild date palm (*Phoenix silvestris*) has produced a low grade of molasses sugar for consumption by the natives for a great number of years. The main obstacle encountered in making a good grade of sugar from this palm has been caused by the difficulty of clarification and the susceptibility of the juice to fermentation. It is thought that the above-mentioned process may bring this palm into greater prominence in the sugar world.

There are also the Palmera (*Borassus flabelliformis*) of Southern India, and the Nipa (*Nipa fructicans*) of the Philippines. Either of these could undoubtedly be made profitable sugar producers. The latter is used commercially only as a source of alcohol.

There is practically no limit to the number of sacchariferous plants one might name in the Tropics and subtropics, but many of these do not contain a sufficient percentage of sucrose, or else they contain such a high percentage of impurities that the low yield of sugar and the high cost of manufacture make their use unprofitable.

CITRUS FRUITS IN THE PHILIPPINES.[1]

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Sation.*

PRELIMINARY REMARKS.

De Candolle, in his "Origin of Cultivated Plants," discusses 5 species belonging to the genus *Citrus:* The pomelo, *C. decumana* L.; the citron, lemon, and lime, here considered as distinct species, which he includes under the one species, *C. medica* L.; the sweet orange, *C. aurantium* L., which he separates from the sour orange and which is also by him considered as a distinct species, *C. vulgaris* Risso; and finally the mandarin, *C. nobilis* Lour. Of these, the pomelo, orange, mandarin, lemon, lime, and citron are important pomologically, the sour orange being grown principally as stock for the other species.

The pomelo is by the same author considered to be indigenous to the Pacific Islands east of Java, the citron and affiliated species to have originated in India, and the sour orange east of India, and all to have been in cultivation for over two thousand years. The antiquity of the orange and mandarin is less, both species being from China and Cochin China.

All these species have been introduced into the Philippine Archipelago, and are well distributed excepting the sour orange, which is rarely seen. The discussion of all species refers to them as found in the Philippines except when otherwise stated.

No very distinct types are found among the oranges or mandarins; the variation in the pomelo is considerable, although,

[1] Bureau of Agriculture Bulletin No. 27, Citriculture in the Philippines, 1913, contains illustrations of several unnamed citrus fruits described in this paper. Those readers who possess the above-mentioned bulletin may be interested to know that in accordance with the classification herein these fruits should be named as follows:

Bull. No. 27, Plate IV, Mandarin Lime=*C. webberii;* VIII, Lime (Mindanao type)=*C. excelsa* var. *davaoensis;* VIII, Lime, "Limon Real"=*C. excelsa;* X, Cabuyao=*C. histrix;* XI, Cabuyao=*C. histrix* var. *torosa;* XII, Biasong=*C. micrantha;* XII, Type from Bohol=*C. histrix* var. *torosa;* XII, Type from Bohol=*C. histrix* var. *boholensis;* XIV, Colo=*C. macrophylla;* XIV, Samuyao=*C. micrantha* var. *microcarpa;* XV, Talamisan=*C. longispina;* XV, Tizon=*C. nobilis* var. *papillaris;* XV, *Tihi-tihi*=*C. medica* var. *odorata;* XVI*a*=*C. webberii* var. *montana;* XVI*b*=*C. southwickii.*

so far as the writer has noted, scarcely enough to warrant the distinction of separate varieties. Both the white and red-fleshed types occur with many gradations, but no studies have been made to note which other correlative characters, if any, are identified with these different forms. The very primitive pomelos (Pl. II, *c*) that are not infrequently seen in cultivation might indicate that this species is indigenous to the Philippines, though so far as the writer knows the tree has never been seen in the virgin forest. Closer observations have been made on the general type represented by the citron, including the lemon and lime, and several distinct forms have been recognized.

The calamondin, *C. mitis* Blanco, is well known to be indigenous, as well as the cabuyao and related plants that have been referred to *C. histrix* DC. In the first-named species there seem to be no very marked variations.

C. histrix was described by De Candolle, flowers and fruits excepted, from a plant growing in Montpellier, being recognized principally by its long broad-winged petioles and free stamens. The writer has not had the opportunity to see the original description of *C. histrix* or examine the type specimen, but Swingle refers to it in Jour. of Agri. Research, Vol. I, No. 1, page 10, 1913, as having broadly winged petioles, often larger than the blades, the wings being more gradually narrowed toward the base and usually more abruptly truncate at the tip than *C. ichangensis* Swingle, making then somewhat triangular in outline.

Within these broad limitations a number of otherwise remarkably distinct forms may be recognized some of which were illustrated in a previous publication, Bureau of Agriculture Bulletin No. 27, Citriculture in the Philippines, 1913, and referred to *C. histrix* with the statement that "some of these forms unquestionably will be recognized as subspecies on closer study, or possibly as separate species." Since then several plants of this type in the citrus collection assembled at Lamao by the Bureau of Agriculture have bloomed and fruited, affording an opportunity for fuller observations, and these have been further complemented during a trip to Bohol and Cebu in May, 1914, and by the fruits forwarded by Mr. E. F. Southwick.

However, assuming that *C. histrix* (or some of its subspecies) is the *C. histrix* of De Candolle, there still remain, on one hand the limao, and on the other the biasong, balincolong, samuyao, samuyao-sa-amoo, as widely different from each other and the cabuyao and its subspecies as for instance the orange, and pomelo, or the mandarin and the calamondin. A very in-

teresting characteristic has been discovered in several of the citrus fruits that have free stamens in the form of a more or less distinct nucleus in the juice cells; this, so far as the writer knows, has not been previously recorded in a citrus fruit. The fact that the presence of these nuclei is not here referred to in some species with free stamens does not necessarily mean that they are absent, considering that fruits of these particular species have not been examined since the first nuclear cells were discovered. The writer is inclined to believe that these nuclei are correlative to those species having free stamens.

To the student in the citrus-growing sections of the United States the characterization of the citron, lemon and lime as given herein is no doubt satisfactory, but in the Philippines various forms called "limon" will appear that do not agree with this and it would then be necessary either to make the descriptions more general so as to cover the additional forms or to classify these as species or subspecies. If the barely margined petioles, comparatively small leaves, the green, tender growth and the white corolla are insisted upon for the lime, for instance, it is difficult to know where to place the purple-growthed, thorny, wide-winged, purplish-petaled, subglobose limes with wide-winged leaves of the Philippines. They cannot well be placed with the lemons, and still less with the citron, though they of course show strong relationship to each. The citron group of the genus perhaps more than any other shows the need of further study and systematization of the entire genus.

Attention should be called to the presence in the Philippines of the extremely primitive types of the citron and the lemons; for instance, the fruit illustrated in Bulletin No. 27, Plate XVI (*c*), and colo-colo, as well as the lombog, referred to *C. pseudolimonum* in this paper.

Of all the plants here discussed, *C. micrantha* var. *microcarpa* is botanically furthest removed from the cultivated citrus fruits.

Each considered as a separate species and constituting perhaps the most complete description of these species published in English, Mr. H. H. Hume's characterization of the orange, sour orange, mandarin, pomelo, citron, lemon, and lime in his "Citrus Fruits and Their Culture," is here reproduced without alteration. Some writers have grouped several of these as subspecies under one great comprehensive species, but, as Mr. Hume aptly says: "What advantage is there in throwing the sour orange, sweet orange, pomelo, kumquat, and a few other distinctly different trees into one conglomerate species * * * and then placing each of the aforementioned plants under this

species as subspecies and varieties. Such a procedure is more likely to result in further confusion than order."

The species of the genus *Citrus* that have come under the observation of the writer, with two exceptions, seem naturally to divide themselves into two groups,—(1) those with more or less united filaments and hypogeal cotyledons, and (2) those with free filaments, and (in all instances where there has been an opportunity for observations) with supra-terraneous, distinct cotyledons (fig. 1). In so far as these characteristics have been observed in the Philippine citrus fruits, long and broad-winged petioles are a third correlative feature distinguishing group No. 2; *C. ichangensis* recently described by Swingle from China also possesses this last feature, but has connate filaments. The alsem and alemow seem to be intermediate between these forms, the alsem being most closely related to those in the first division, the filaments being connate, while the cotyledons in some lots that have been propagated appeared above ground. The alemow is most closely related to group No. 2, the filaments being nearly always free. The general character of the talamisan together with the presence of hypogeal cotyledons tends to the belief that this species has more or less united filaments and thus would belong to the first group.

All descriptions have been made from living plant material either during tours of collection by the writer, or from plants grown at the Lamao experiment station from material sent to the Bureau of Agriculture from time to time since April, 1911. Also, all the material has been collected from plants growing in the yard of some Filipino and so may lay claim to having been domesticated. While this statement may not be altogether reliable it is interesting to note that in Bohol the Filipinos stated that the following trees grew wild in the forest: Amongpong, amontay, balincolong, biasong, canci, colo-colo, limoncito, limao, lombog, and samuyao.

While it is believed that the species described in this paper include most of the more distinctive Philippine citrus fruits, and several hitherto unknown even to the botanist, they do not by any means exhaust the Philippine forms of this genus. Several other forms have been noted, and constitute a part of the citrus collection at Lamao but are not here referred to, for the reason that the material on hand is too incomplete to warrant their description at this time.

Acknowledgements.—The writer is greatly indebted to Mr. E. F. Southwick, superintendent of the demonstration station at Cebu, for his untiring zeal in repeatedly forwarding sets

of citrus fruits and budwood from Bohol and Cebu, and for his most valuable assistance during a collection trip made by him and the writer to Cebu and Bohol in May, 1914, without which it would not have been possible to obtain much of the data and material collected. All the species and varieties credited to Bohol were first called to the attention of the Bureau by Mr. Southwick. Mr. G. W. Weathersbee, formerly agricultural inspector of this Bureau, first called attention to the alemow and has also assisted in the collection of citrus material in Cebu. Mr. A. M. Burton, formerly superintendent of the Trinidad garden, Benguet, has forwarded fruits and budwood of the cabugao and other fruits. Mr. D. B. Mackie, entomologist of the Bureau, first called attention to a variety of alsem in Bontoc of superior quality. M. G. B. Mead sent the first specimens of Panuban.

DESCRIPTIONS AND COMMENTS.

Citrus aurantium L. ORANGE.

A tree 7.5 to 12 meters in height, with a compact, conical head; bark grayish brown; thorns generally present, 12 to 50 millimeters long, sharp, stout; leaves oval or ovate oblong, 7.5 to 10 centimeters long, smooth, shining, somewhat lighter below than above, margins entire, or very slightly serrate; petiole 12 to 25 millimeters long, slightly winged (occasionally with quite a broad wing); flowers axillary in clusters of one to six, white, sweet scented, smaller than those of *C. vulgaris;* calyx cupped; sepals four to five, awl-shaped, thick, greenish, persistent; petals usually five, oblong, 25 to 31 millimeters long, thick, fleshy, recurved; stamens twenty to twenty-five, hypogenous, filaments flattened, united in groups, shorter than the petals; pistil distinctly divided into stigma, style and ovary; stigma knob-like; style long and slender; ovary rounded, 10 to 14 loculed; fruit globose to oblate, light orange to reddish; rind smooth; pulp juicy, subacid; juice sacs spindle shaped, sometimes larger than those of *C. vulgaris;* seeds few or many, oblong ovoid, planoconvex, generally broad, wedged or pointed at the micropylar end, marked with oblique ridges surrounding one or two plain areas. Native to China or Cochin China.

While the orange is nowhere planted in orchards it is fairly well distributed. Judging from the prevalence of the citrus fruits in the markets in the various parts of the Archipelago it ranks fifth in production, as compared with the mandarin, pomelo, lime, and calamondin, the only citrus fruits beside the orange that may claim to be of any economic importance even from a Philippine point of view. Excepting a few budded trees of recent importation or distribution by the Bureau of Agriculture all trees are seedlings and nearly always the fruit is poor in quality.

So far as noted, there are no variations worthy of notice.

Citrus vulgaris Risso. SOUR ORANGE.

(Seville orange, Bigarade orange.)

A small tree, 6 to 9 meters in height, with a dense compact head; young shoots light green, thorny; thorns alternate, small, sharp and pointed, on older wood larger, strong, stiff; leaves unifoliate, evergreen, alternate, ovate, pointed, strongly and peculiarly scented; petiole 12 to 18 millimeters long, broadly winged; flowers in small, axillary cymes, white, strongly sweet scented, somewhat larger than those of *C. aurantium;* calyx cupped, segments 4 to 5, blunt; petals linear oblong, conspicuously dotted with oil cells; stamens 20 to 24; filaments united in groups; pistil club shaped, smooth; ovary 6 to 14 loculed; fruit orange colored or frequently reddish when well matured, inclined to be rough; rind strongly aromatic, bitter; pulp acid; juice sacs spindle shaped, rather small; seeds flattened and wedged toward the micropylar end, marked with ridged lines. Native to southeastern Asia, probably in Cochin China. Hardier than the sweet orange.

Samples of what seems to be the sour orange have been received from Davao, Mindanao.

Citrus nobilis Lour. MANDARIN.

A small tree 3.6 to 6 meters in height, with a dense head of upright or willowy, drooping branches; bark dark brownish or streaked with gray; branchlets light green or dark in color, small, slender, round or angled, thornless, or provided with small sharp spines; leaves small, lanceolate to oval, slightly crenate; petioles short, wingless, or with very small wings; flowers terminating the branchlets or axillary, sometimes clustered, 18 to 25 millimeters across, sweet scented; calyx small, shallow, cupped, the petals small; petals white, fleshy, recurved; stamens 18 to 23 in number, shorter than the petals; pistil small, resembling that of *C. aurantium;* ovary 9 to 15 loculed; fruit distinctly oblate, orange to reddish in color; pulp sweet or subacid; juice sacs broad and blunt; seeds top shaped, beaked, cotyledons pistache green; embryos one or more; sections separating readily from each other and from the rind; rind thin, oil cell somewhat balloon shaped or oval. Native to Cochin China. Generally admitted to be somewhat hardier than the sweet orange.

The mandarin is the only species in the genus *Citrus* that has been at all systematically planted and cared for, even though this mostly consists in the planting the trees, now and then the clearing away of the weeds with cutlasses and the harvesting of the fruit. Nevertheless the quality of the fruit is uniform and very good.

The mandarin district of the Philippines is confined to a small area principally around Santo Tomás and Tanauan, in the Province of Batangas, and, excepting imported fruit, all mandarins marketed in the Philippines are grown in the above-mentioned region. Scattered trees are found in most parts of the Archipelago. Aside from the tizon, which is described later, and

which it is believed may be referred to this species, there are no well-defined varieties of the mandarin.

Citrus nobilis var. *papillaris* Blanco. TIZON.

(Plate II, *b*)

A spreading, small tree, attaining a height of 6 meters or more, in habit similar to the pomelo; spines small, or wanting; leaves 10 to 14 centimeters long, 5 to 6 centimeters broad, ovate to elliptical oblong, crenate, dark-green and shining above, crinkly, base broadly acute, apex narrowly acute to almost acuminate and caudate; petioles 17 to 20 millimeters long with narrow wing margin; flowers not seen; fruit large from 6 to 10 centimeters in diameter, 170 to 580 grams in weight, somewhat compressed at basal half, usually ending in a more or less conspicuous nipple which, however, is sometimes wanting; apex flattened, or even depressed; surface smooth, pale greenish turning to orange yellow; skin medium thin; locules 10 to 11, separable from each other and the skin like the mandarin; pulp yellowish, subacid, very juicy, and of good flavor with marked "quinine" taste; juice cells large; seeds very few, rarely more than 7.

The tizon is extremely rare and only a few trees are found in cultivation, confined to the citrus district of Batangas, Luzon. The trees are said to be quite prolific, and the fruit matures from September to December. This fruit, on account of its scarcity, is of no commercial importance. However, it would be an acceptable dessert or breakfast fruit, being a little more acid than the orange. It is said to be an introduction from Spain. The tizon is without doubt the *C. papillaris* described by Blanco in "Flora Filipinas."

The tizon is believed to be a natural hybrid between the mandarin and the pomelo. It has inherited the loose-skinned character, large juice cells, and partial absence of spines, and leaf character of the first-named species to which it is (without the writer having had the opportunity to examine the flowers) unquestionably more closely related than to any other species in the genus. The tizon is represented in the citrus collection at the Lamao experiment station under Bureau of Agriculture No. 744 and 745.

Citrus decumana L. POMELO.

A tree 6 to 12 meters in height, with a rounded or conical head, and a trunk upwards of 45 centimeters in diameter; bark smooth, grayish brown; young leaves and shoots sparsely pubescent, light green; leaves ovate, blunt, pointed or rounded, emarginate, smooth, dark, glossy green, leathery, margin crenate; petioles articulated, broadly winged; flowers produced singly or in cymose clusters of 2 to 20, sweet scented; calyx cupped, large; sepals 4 to 5, pointed; corolla white, 37 to 43 millimeters across; petals 4 to 5, slightly reflexed, fleshy, oblong; stamens 20 to 25;

anthers large, abundantly supplied with pollen, proterandrous; pistil stout; stigma when ripe covered with a sticky, milky fluid; ovary 11 to 14 loculed; fruit large, oblate, globose or pyriform, light lemon or orange colored; flesh grayish or pink; juice sacs large, spindle shaped; flavor a mingling of acid, bitterness and sweetness or subacid; seeds large, light colored, wedge shaped or irregular, with prominent ridges surrounding broad, flat areas. Native to the Polynesian and Malayan Archipelagos.

The pomelo is the most widely distributed species in the genus, but here as in the orange the quality of practically all the fruit is wretchedly poor, dry and insipid with a very thick skin. With the exception of the panuban, described below, there are no variations worthy of notice in this genus.

Citrus decumana L. POMELO, var. PANUBAN.

A spiny tree, 3 to 4 meters tall of robust growth; young growth pubescent; leaves 12 to 17 centimeters long, 4.7 to 8 centimeters wide, oblong ovate, crenate, coriaceous; base rounded; petiole 15 to 23 millimeters long, wing margins narrow, at most 18 millimeters broad, and cuneiform; flowers not seen; fruit 5.7 centimeters long, 7 centimeters in transverse diameter, oblate, with shallow apical cavity; surface smooth, lemon yellow; skin very thin; pulp contained in 11 to 12 locules, yellowish, fairly juicy, subacid, acidity and sweetness well blended, aromatic and well flavored; seeds large, polyembryonic.

The panuban is said to bloom about New Year and the fruit ripens in September to November; the trees are reported to be very prolific. The panuban has been reported only from Lias, Bontoc, where half a dozen trees are said to grow. Possibly the panuban may be an accidental hybrid between the pomelo and the orange or mandarin; if it is simply a mutation it is certainly one of the most striking in this species. However this may be, the pomelo character is strongly dominant in both the foliage and the fruit. Very well flavored, the fruit is too dry to be acceptable to a discriminating public, but it is not improbable that under cultivation the juiciness would increase. In such a case the panuban might become a fruit of commercial importance.

B. A. No. 5160 (Lias, Bontoc).

Citrus mitis Blanco. CALAMONDIN.

A small, somewhat spiny tree, 4 to 6 meters tall; young growth greenish; leaves elliptic oblong, 4 to 9 centimeters long and about 4 centimeters wide, crenulate; base acute; apex usually emarginate; petiole scarcely winged, 10 to 15 millimeters long; flowers axillary, solitary, rarely in pairs, 21 millimeters in diameter, fragrant; petals white, reflexed; stamens 18 to 20, unequal; filaments united into groups; ovary globose, 6 to 8 loculed; style slender, distinct; stigma knoblike; fruit globose, orange

yellow, 2 to 4 centimeters in diameter; skin smooth, thin, brittle, separable from the flesh; pulp orange colored, juicy, acid, with distinct aroma; juice cells rather large, short, and blunt; seeds comparatively large, smooth, plump, sometimes beaked; polyembryonic.

The calamondin is widely distributed in the Philippines and occurs wild as well as cultivated. The plant makes an attractive, ornamental, small tree and the fruit may be made into marmalade or utilized in making ade. There are no particularly distinct forms of this species. The trees are almost invariably very prolific and almost everbearing. In Bohol the species is known as "limoncito."

B. A. No. 2332 (Tanauan, Batangas).

Citrus webberii. ALSEM.

A shrubby tree with small, sharp spines; leaves averaging 95 millimeters in length, and 32 millimeters in width, oblong-ovate, crenulate, dark green and shining above; base broadly acute; apex emarginate, petiole 27 millimeters long; wings rarely exceeding 12 millimeters in width; flowers terminal, rarely axillary, solitary, 20 millimeters in diameter, sweet scented; calyx small; petals white, reflexed; stamens 19 to 21, about equal; filaments united into groups of several; ovary small, obovoid, 7 to 11 loculed; style distinct, slender; stigma small, club shaped; fruit sometimes attaining a weight of 165 grams, form oblate, 58 millimeters long to 65 millimeters long to 66 across, to roundish oblate, sometimes compressed and wrinkled toward base ending in a pronounced nipple; apex a shallow depression, or mammilate with the circular depression more or less pronounced; surface smooth to fairly smooth; color greenish yellow to lemon yellow, lenticels few, depressed; skin thin, the "kid-glove" character more or less pronounced; flesh whitish to grayish, very juicy, aromatic; juice cells variable, from short and blunt to medium slender and tapering to one end; seeds ovate, flattened, smooth, sometimes beaked.

Plants of the alsem have never been seen by the writer in the provinces, the description of the plant having been made from budded plants growing at Lamao, propagated from material collected in Bulacan. The trees have a long flowering season, as fruits are offered in Manila throughout the summer to late in autumn. The variation in the fruit is very great, some being of little value, while others are extremely thin skinned, well flavored, juicy, aromatic, with less rag than perhaps any citrus fruit that has been examined by the writer. The floral characters correspond closely to those of the mandarin, which the fruit in some forms also resembles in appearance and in its loose-skinned character. Flavor and aroma place the alsem in close relationship with the cabuyao, *C. histrix*, and it is a curious fact that the Tagalogs always call it "cabuyao." In common with the cabuyao it is frequently infested with the

rindborer, *Prays citri,* while the mandarin is practically immune to this pest.

An analysis made by the Bureau of Science in November, 1912, of alsem fruits purchased by the writer in Manila gave the following results:

Weight of—	Grams.
Fruit	56.5
Peel	15
Seed	1.5
Pulp (rag)	13.5
Juice	26.5

Analysis of juice.

	Per cent.
Acidity (citric)	5.41
Sucrose	None.
Sugar	2.41
Protein	.33
Ash	.39

Analysis of pulp.

	Per cent.
Acidity (citric)	2.73
Protein	1.03
Ash	.58

The alsem was considered a variety of the mandarin in Bulletin No. 27, Plate IV, but a closer study of the plant and fruit shows that it differs so greatly from all other Philippine species of the genus as to be entitled to specific rank, and it has been named in honor of Dr. H. J. Webber, director of the citrus experiment station, Riverside, California, the association with whom, in connection with his citrus and pineapple breeding work, more than any other cause influenced the writer to take up the improvement of tropical economic plants.

The Bontoc local name "alsem" is here proposed as the vernacular name for *C. webberii.* In previous publications by the writer it was called the "mandarin lime," which is hardly suitable, however, since while it has certain resemblances to the mandarin yet is distinct from it, and again, its only resemblance to the lime lies in its acidity and ade-making qualities; moreover the name "mandarin lime" is too long for popular use.

B. A. No. 853 (Bulacan), 2275 (Manila), 4292 (Bontoc).

Citrus webberii var. *montana.* CABUGAO.

A shrubby tree with slender branches and small, weak spines, sometimes absent; young growth green; leaves 8.5 to 14 centimeters long, 3 to 3.5 centimeters broad, ovate to ovate oblong, crenate, dark green above, shining; base broadly acute to rounded; apex blunt pointed, usually retuse;

petiole 24 to 38 millimeters long, with narrow wing margin, in large leaves sometimes 17 millimeters broad; flowers not seen; fruit roundish oblate, about 45 millimeters across, somewhat corrugate, 8 loculed.

Budwood and fruits of the cabugao were forwarded to the Bureau by Mr. A. M. Burton, from the Mountain Province. The writer did not have the opportunity of examining the fruit, of which, however, an excellent photograph was made, and, to date of writing the plants at Lamao not having bloomed there has been no chance to examine the floral characters. The general character of the plant and fruit indicates that the cabugao is a form of the alsem.

Through a typographical error in Bulletin No. 27, Plate XVI (*a*), the cabugao is credited to Bohol.

B. A. No. 2266 (Benguet, Mountain Province).

Citrus longispina. TALAMISAN.

(Pls. II*a*, III*a*.)

An arborescent, very thorny shrub about 5 meters tall, with numerous suckers and interlocking branches, the spines on the stems frequently 10 centimeters long; young growth bright green, nearly always angular; leaves 6.5 to 10 centimeters long, 3 to 4.8 centimeters broad, ovate to broadly elliptical, crenate; base obtuse to broadly acute; apex acute to rounded, usually emarginate; petioles 19 to 25 millimeters long, rather narrowly winged, though in large leaves the wings are up to 18 millimeters broad; flowers not seen; fruit roundish, somewhat flattened at apex, 58 millimeters in diameter, smooth, deep lemon colored; skin thin; locules 11 to 15; pulp very juicy, mildly acid, with a tinge of orange yellow, aromatic and pleasantly flavored; juice cells large, plump, blunt or pointed at one end; seeds rather few, of medium size, fairly plump, more or less reticulate, polyembryonic, and of poor germinating qualities.

The talamisan is exceedingly rare, and is found in cultivation in Bohol (one plant has been seen in Cebu) and is fairly productive. Excepting the mandarin, which is also of rare occurrence, it is much superior to all other citrus fruits grown in these two islands, and is eaten by the inhabitants; it is nevertheless very rare and of no economic importance at present. The fruit ripens in January and February, and is a poor keeper. Introduced into cultivation, the fruit of the talamisan could to advantage be used as an ade fruit, and with a little sugar it would make a good breakfast fruit. The dense growth of the plant, with numerous suckers, armed also with formidable spines, would make it a good live fence.

The talamisan, or tamisan as it is also called, is one of the most interesting citrus fruits that has come to the attention of the writer. Its angular growth, formidable spines, broad, some-

times almost orbicular, distinct leaves and fruit easily distinguish the talamisan from all other species in the genus.

B. A. No. 2529, 4833 (Bohol).

Citrus macrophylla. ALEMOW.

(Pls. III*b*, VI*c*.)

A tree attaining a height of 6 meters, of upright growth, and rather long, stout, sharp spines; leaves 14 to 18 centimeters long, 6 to 8 centimeters wide, elliptical to ovate, crenate to serrate; base rounded; apex acute; petioles 18 to 40 millimeters long, broadly winged, wings frequently exceeding 35 millimeters in width; flowers 4 to 7, in compact cymes, sessile, 18 to 22 millimeters in diameter; calyx cupped; petals 4 to 5, oblong; stamens 26 to 30; filaments nearly always free; ovary small, 13 to 16 loculed; style distinct; stigma club shaped, small; fruit 85 to sometimes exceeding 100 millimeters in length, attaining a weight of 500 to 800 grams, subglobose to roundish oblong, more or less compressed towards base, which is nippled and with stem inserted in a shallow cavity; apex flattened with a circular depression around the raised stigmatic area; surface greenish lemon yellow, rather rough, with transverse corrugations; oil cells small, sunken; skin comparatively thin; pulp grayish, rather dry, sharply acid, lemon flavored; juice cells rather slender, long, and pointed; seed medium large, short and plump, smooth, sometimes beaked.

The alemow is a very rare fruit occurring in cultivation in Cebu, and considered inedible even by the natives. The description of the flowers was made from fresh specimens collected in May. The tree is said to bloom later in the year during the rainy season having then larger flowers. Partly grown fruit was then seen on the tree and since mature fruit has been examined by the writer from December to late in February the alemow is evidently nearly if not quite everbearing.

The principal distinguishing features in this species are the large, broad leaves, the comparatively short but quite broad-winged petioles, the free rarely united filaments, and the quite large, peculiarly shaped fruit; it is thus apparently one of the links between the two branches of the genus, one of which has the filaments more or less united and the other the filaments free, being in the first group most closely related to the pomelo.

The alemow was first forwarded to the writer under the name of colo: Bulletin 27, Plate XIV.

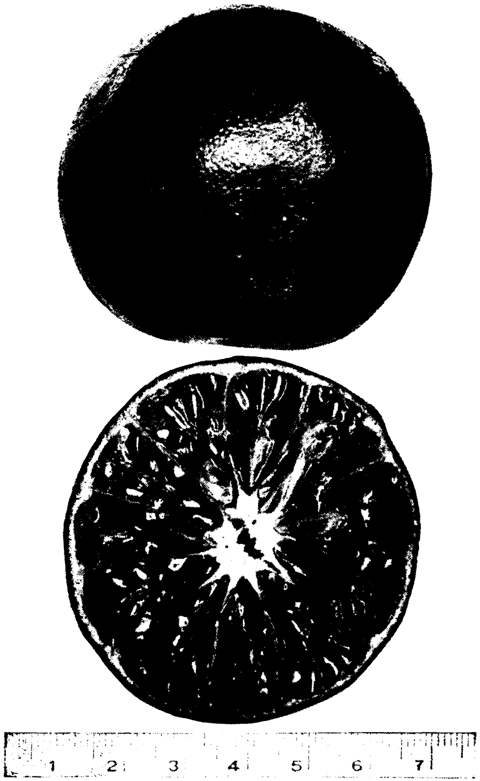
B. A. No. 2510, 2377, 3677, 4820 (Cebu).

Citrus southwickii. LIMAO.

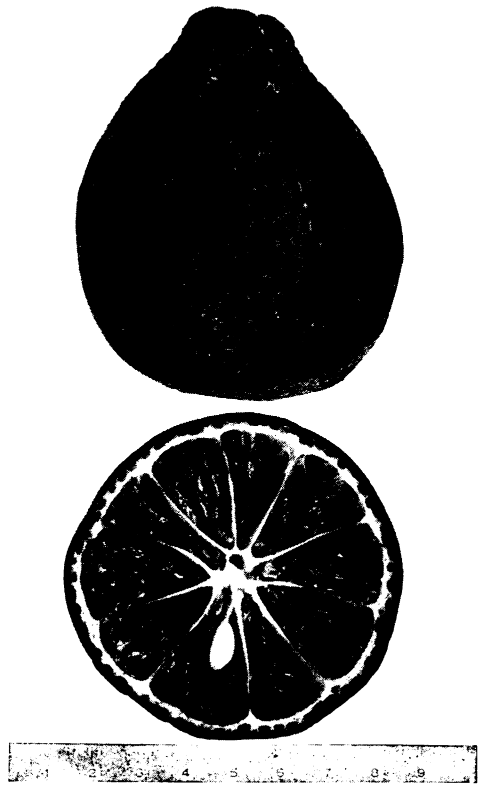
(Pls. III*e*, IV*c*.)

A thorny tree, with dense head and drooping branches, attaining a height of 6 meters; spines small but sharp, leaves 9.5 to 14 centimeters long, 36 to 53 millimeters broad, ovate to roundish ovate, conspicuously crenate,

PLATE II.



(*a*) Talamisan (*Citrus longispina* sp. nov.).



(*b*) Tizon (*Citrus nobilis* var. *papillaris* Blanco).

(*c*) Primitive type of the Philippine pomelo (*Citrus decumana* L.).

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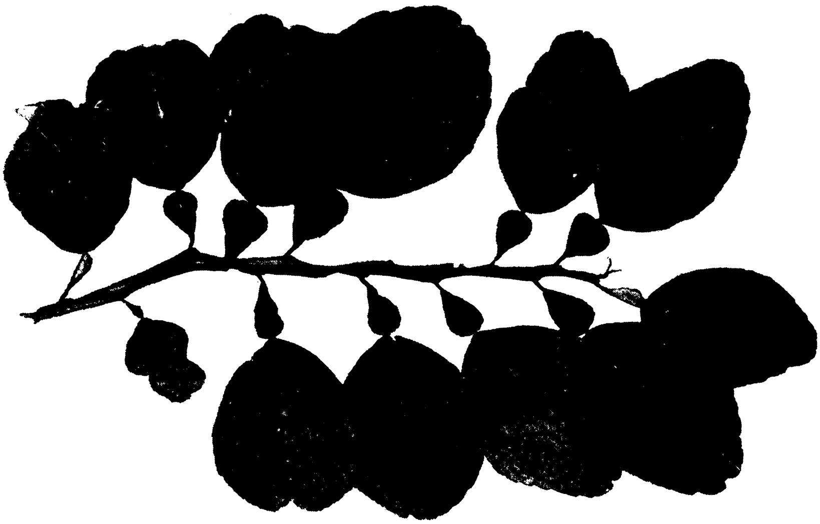

(*a*) Talamisan (*Citrus longispina* sp. nov.).

(*b*) Alemow (*Citrus macrophylla* sp. nov.).

(*c*) Limao (*Citrus limao* sp. nov.).

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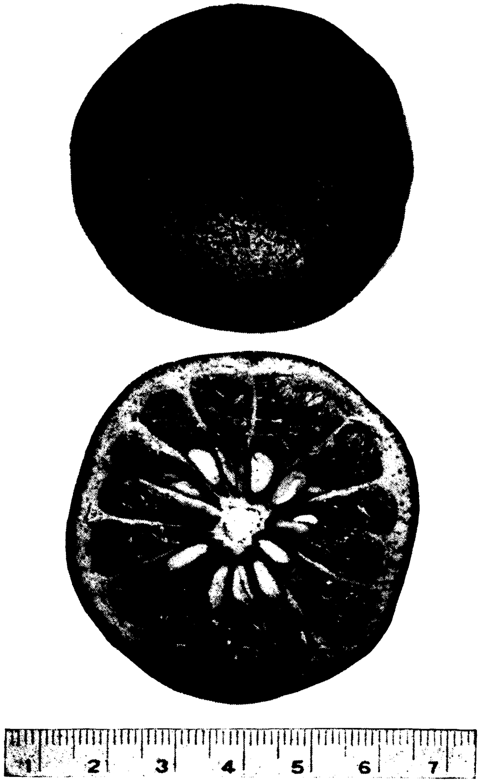
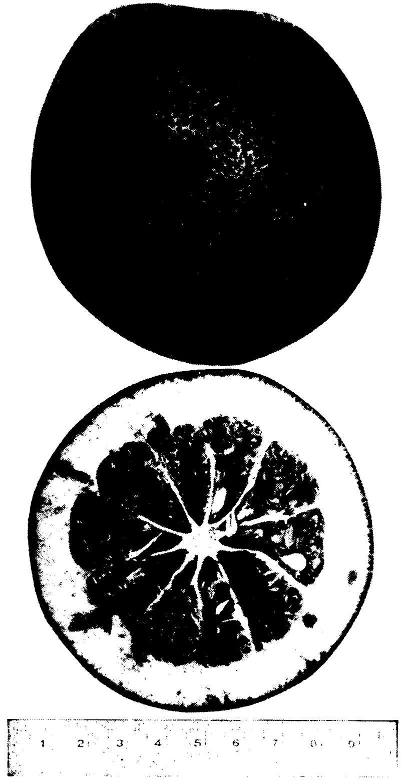
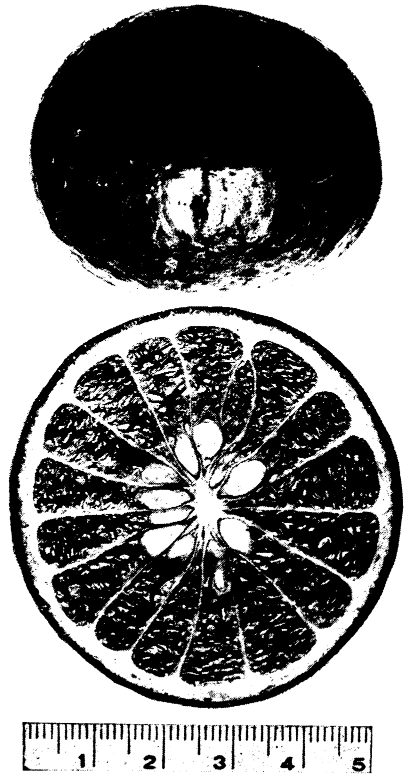
PLATE IV.



(a) Canci (*Citrus histrix* var. *boholensis*).



(b) Cabuyao (*Citrus histrix* DC. var. Amontay).



(c) Limao (*Citrus southwickii* sp. nov.).

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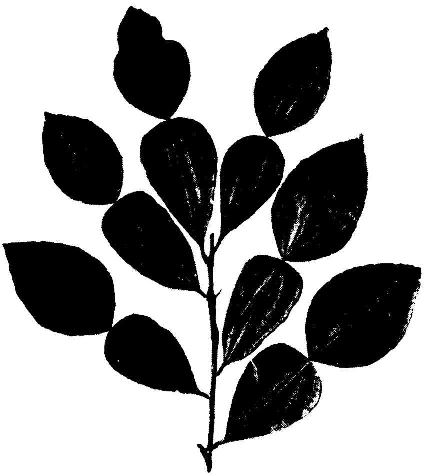
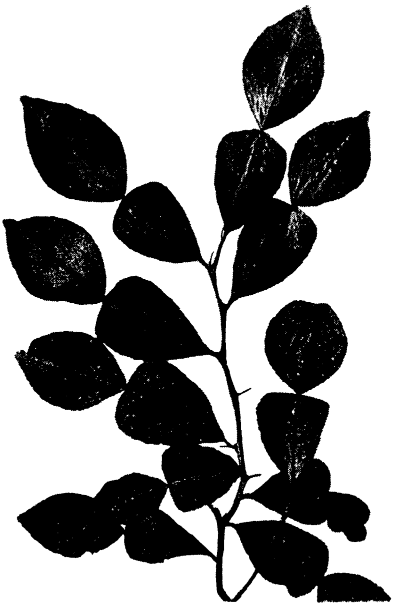
(*a*) Canci (*Citrus histrix* var. *boholensis* sp. nov.).



(*b*) Cabuyao (*Citrus histrix* DC. var. "Copahan").



(*c*) Biasong (*Citrus micrantha* sp. nov.).

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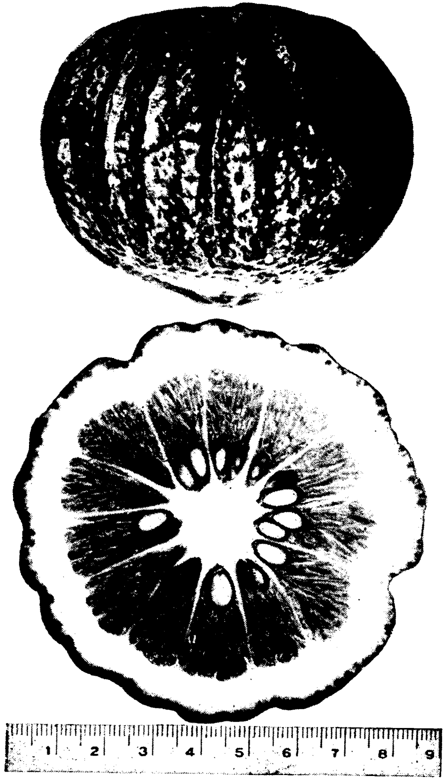
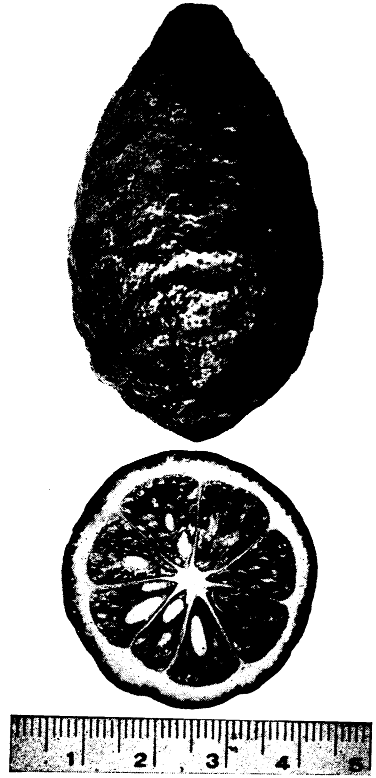
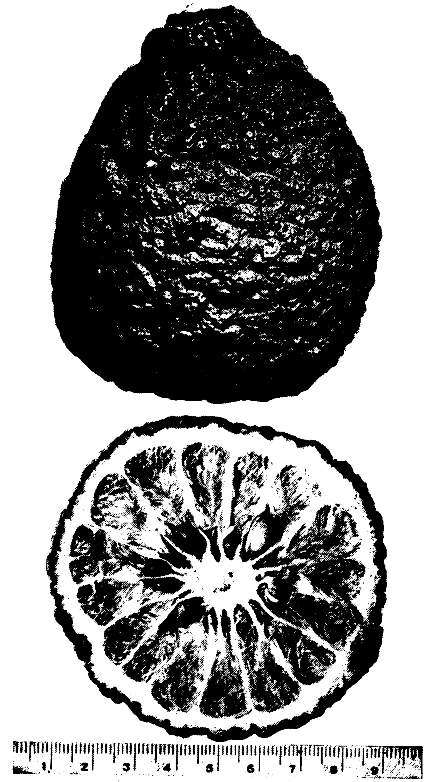
PLATE VI.



(a) Tihi-tihi (*Citrus medica* var. *odorata* sp. nov.).



(b) Biasong (*Citrus micrantha* sp. nov.).



(c) Alemow (*Citrus macrophylla* sp. nov.).

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PLATE VII.

(*a*) Colo-colo (*Citrus pseudolimonum* sp. nov.).

(*b*) Samuyao (*Citrus micrantha* var. *microcarpa* sp. nov.).

(*c*) *Citrus micrantha* sp. nov. var. "Balincolong."

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dark green and shining above, leathery; base acute; apex acute to obtuse, frequently emarginate; petioles 35 to 70 millimeters long, the wings 25 to 30 millimeters broad in large leaves, the average wing area somewhat less than half of the leaf blade; flowers 2 to 6, in compact axillary or terminal cymes, sometimes solitary, 14 to 20 millimeters in diameter, white, with trace of purple on the outside; calyx very small; stamens 22 to 28, free; ovary globose to oblate; locules 15 to 19; stigma almost sessile; fruit 45 to 55 millimeters long, 55 to 65 millimeters in equatorial diameter, oblate, with shallow cavity at apex, smooth, with slight longitudinal corrugations; lenticels sparse, small; oil cells usually raised; skin thin; pulp fairly juicy, sharply acid, bitter, with distinct aroma from *C. histrix;* juice cells short, plump, granulate, small, containing a small, greenish nucleus; seeds numerous.

The limao, though rare, is not uncommon in Bohol, where it is cultivated and has also been collected by the writer in Baganga, Mindanao. The flowers appear late in April and during the early part of May, with the fruit ripening in January and February; a few fruits nearly full grown were collected in May. No. 2049 has flowered irregularly from May to December. The fruit is not eaten, but used in washing by the Boholanos and is of no economic importance. The tree is evidently quite drought resistant, and succeeds well in very scanty soil underlaid with limestone.

The limao belongs in that group of the citrus fruits having free filaments, the most conspicuous characters being the compact growth of the crown, the dark-green, thick, and distinct leaves, the almost sessile stigma, and the attractive, oblate, regular-shaped fruit with its many locules, exceeding in number those in all other citrus fruits known to the writer. This species has been named in honor of Mr. E. F. Southwick, elsewhere referred to in the paper.

B. A. No. 2049 (Baganga, Mindanao), 2504, 4823 (Bohol).

Citrus histrix DC. CABUYAO.

(Pl. V*b;* fig. 1.)

A thorny tree, sometimes exceeding 6.5 meters in height; spines medium large and sharp; leaves 13.5 to 18 centimeters long, 4 to 6 centimeters broad, ovate to oblong ovate, coriaceous, dark green and shining above, crenate; base rounded to broadly acute; apex acute, sometimes emarginate; petiole 5.5 to 8 centimeters long, broadly margined, sometimes 4.5 centimeters wide, wing area inferior or equal to sometimes exceeding leaf area; flowers 4 to 7, in axillary or terminal, compact cymes, 17 to 28 millimeters in diameter; calyx small, not cupped; petals 4 to 5, oblong ovate, white, with trace of purple on the outside; stamens 30 to 36, equal, free, with abundant pollen; ovary rather large, globose, 13 to 18 loculed; style short and stout; stigma knob like; fruit subglobose to short pyriform or turbinate, attaining a length of 9 centimeters and a diameter of 7 centimeters;

surface smooth; color greenish yellow to lemon yellow; rind medium thick; pulp greenish, juicy, sharply acid, aromatic; juice sacs rather short and blunt, usually containing a more or less distinct nucleus; seeds usually many, flat, reticulate.

This fruit, commonly called cabuyao by the Tagalogs in central Luzon, is without question the "copahan" of Bohol. Near Manila the tree has been found in flower in September, while in Bohol flowers were collected in May. The fruit may be used in making ade, but is inferior to the lemon or lime. The native inhabitants eat it together with fish, and also use the fruit in washing. It is of practically no importance.

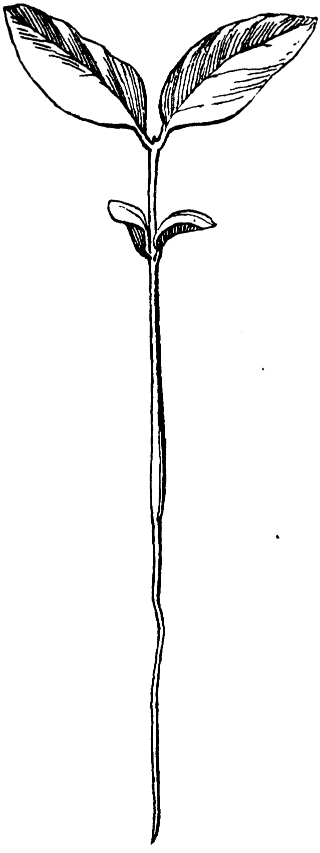

FIG. 1. Seedling of *C. histrix* DC., illustrating the distinct supraterraneous cotyledons.

The "amongpong," found in Bohol, and considered a distinct fruit from the copahan by the native inhabitants, differs chiefly in having only 26 to 30 stamens, and a large oblate ovary with a short and slender style. The first has not been examined by the writer and is said to be smooth and short, pyriform, 10 centimeters in diameter. Flowers examined in May.

"Calo-oy" is another fruit also found in Bohol considered by the inhabitants as distinct from the "copahan" and "amongpong." The leaf characters in the calo-oy scarcely differ sufficiently to entitle it to rank even as a subspecies; the flowers were just gone when the visit was made to Bohol. The fruit is said to be globose, smooth and about 8 centimeters in diameter.

"Amontay" (Pl. IV*b*) is still another form of *C. histrix* found in Bohol. This plant was also out of its flowering stage at the time of the visit. The fruit, forwarded to the writer in February by Mr. Southwick, is about 88 millimeters in diameter, irregularly globose, with flattened or depressed base, and rounded apex, smooth, lemon yellow; oil cells mostly raised; skin thick; the pulp, contained in 10 to 12 locules, juicy, and rather pleas-

antly aromatic; juice cells medium large, short and plump, containing a minute, greenish nucleus; cotyledons supraterraneous, distinct.

So far as observed, the amongpong, amontay and the calo-oy are not sufficiently distinct from the cabuyao to entitle them even to rank as subspecies.

The various forms above referred to are in the Bureau of Agriculture citrus collection at Lamao, represented as follows: Cabuyao, No. 739 (Lamao) ; copahan, No. 2570, 4835 (Bohol) ; amongpong, No. 2496, 4831 (Bohol) ; calo-oy, No. 4822 (Bohol) ; amontay, No. 2501, 4830 (Bohol).

Citrus histrix var. *boholensis*. CANCI.

(Pls. IV*a*, V*a*.)

A small tree, rarely exceeding 4 meters in height, with compact crown and small, sharp spines; leaves 9 to 12 centimeters long, 30 to 45 millimeters broad, ovate to elliptical ovate, crenulate, coriaceous; base broadly acute; apex acute to acuminate; petioles 35 to 45 millimeters long, 25 to 30 millimeters wide, wing area less than one-half of leaf area; flowers 2 to 6 in compact axillary cymes; petals white, with purplish tinge outside; stamens 20 to 23, equal, free; ovary quite large, oblate; locules 11 to 14; style short, distinct; stigma knob like; fruit 39 millimeters long, 46 millimeters in transverse diameter, oblate, smooth, lemon yellow; oil cells numerous, uniform, raised; skin medium thick; pulp quite juicy with very pronounced acidity; juice cells short, plump, and granular; seeds many, wedge shaped, monoembryonic; cotyledons supraterraneous.

The canci is found in cultivation in Bohol and is rather rare. Flowers were collected in May, and ripe fruits have been examined in January. The fruit is eaten with fish by the Filipinos, but is really so little grown that it has no economic importance. The fruit makes a fairly good ade.

While the canci undoubtedly belongs to *C. histrix* yet an examination of its parts shows that it is very distinct from that species as already described. In the leaves, the comparatively short petioles with small, cuneiform wings, as compared with the oblong-spatulate, broad-winged petioles in the cabuyao, etc., is very noticeable; the stamens are 20 to 23 only in the canci, while the locules are 11 to 14, and the fruit is shorter than broad unlike that in *C. histrix*. Everything considered the plant is apparently an intermediate type between *C. histrix* and *C. webberii*.

B. A. No. 2525, 4824 (Bohol).

Citrus histrix var. *torosa* Blanco. COLOBOT.

A spiny tree, attaining a height of 6 or more meters; young growth green with a tinge of purple; leaves 9 to 13 centimeters long, 3.5 to 5.5

centimeters broad, ovate to short ovate, bicrenate, dark green and glossy; base rounded, apex emarginate; petiole 4 to 7.5 centimeters long, 2.9 to 5 centimeters wide, oblong, with a broadly acute to obtuse base; wing area nearly equal to or frequently exceeding the leaf area; flowers 20 millimeters across, in axillary clusters of 2 to 6; pedicel slender; calyx small, not cupped; petals 4 to 5, white, with a tinge of purple on the outside; stamens 21 to 26, free, equal; ovary subglobose, 3 millimeters long, 11 to 14 loculed; style short, 1 millimeter long, distinct; fruit 48 to 55 millimeters long, and about 50 millimeters in transverse diameter, irregularly globose to oblate, usually compressed towards base, ending in a small nipple, more or less wrinkled, greenish lemon yellow; pulp greenish, fairly juicy, acid, scarcely edible; juice cells small, short, containing a small greenish nucleus; seeds small, oblong, reticulate.

This plant is the *C. torosa* of Blanco, which has been considered a synonym of *C. histrix*, and here raised to the rank of a subspecies. A comparative study of *C. histrix* and the variety *torosa* shows considerable differences between the two. *C. histrix* is generally larger in all parts; the wings of *C. h. torosa* are oblong, maintaining an almost equal width over a large part of the petiole, ending in a rounded to a broadly acute base, while in *C. histrix*, and in fact in all the species herein described with free stamens, the wings are more or less cuneate to elongate cuneate or oblong-spatulate, ending usually in an acuminate, sometimes an acute base, the one closest approaching the *C. h. torosa* in this respect being the "balincolong," referred to *C. micrantha*. The flower of *C. h. torosa* corresponds with that of *C. histrix* except that the former has 21 to 26 stamens as compared with 30 to 36 in *C. histrix*, which also averages more locules to a fruit.

B. A. No. 3665, 3666 (Batangas).

Citrus micrantha. BIASONG.

(Pls. V*c*, VI*b*, VII*c*.)

A tree attaining a height of 7.5 to 9 meters, with comparatively small but sharp spines; leaves 9 to 12 centimeters long, 27 to 40 millimeters broad, broadly elliptical to ovate, crenate, rather thin; base rounded or broadly acute; apex acutely blunt pointed; petioles 35 to 60 millimeters long, broadly winged, up to 40 millimeters wide; wing area sometimes exceeding leaf area; flowers small, 12 to 13 millimeters in diameter, white, with a trace of purple on the outside, 2 to 5, in axillary or terminal cymes; petals 4; stamens free, equal, 15 to 17; ovary obovoid, locules 6 to 8; style slender, distinct; fruit 5 to 7 centimeters long, 3 to 4 centimeters in transverse diameter, averaging 26 grams in weight, obovate to oblong-obovate, somewhat compressed towards base; apex blunt pointed; surface fairly smooth or with transverse corrugations, lemon yellow; skin comparatively thick; pulp rather juicy, grayish, acid; aroma similar to that of the samuyao; juice cells short and blunt to long, slender and pointed, sometimes

containing a minute, greenish nucleus; seeds many, flat, pointed, more or less reticulate.

The biasong has been collected in Cebu, Bohol, Dumaguete, Negros, and in the Zamboanga and Misamis Provinces in Mindanao, in all of which it is sparingly cultivated. The flowers were described from material collected in Bohol in May. Ripe fruit has been obtained in May, June, August, November, and February, indicating that the species is more or less everbearing. The fruit is used by the native inhabitants as a hair wash, is not eaten, and is of no economic importance.

Particularly noticeable in the biasong are the small flowers, with less stamens than any other species, and the oblong-obovate, few-loculed fruits.

The "balincolong," by the Filipinos regarded as quite a different fruit, found in Bohol and in Misamis, Mindanao, is a more robust tree attaining a height of 12 meters, and has longer wings and thicker leaves, with smoother fruits which sometimes are almost round, but these differences scarcely justify this form to rank as a subspecies even. Beginning in May, the balincolong (1982) has bloomed continuously at Lamao until date of writing (Dec. 18).

Biasong, B. A. No. 2502, 4829 (Bohol), Balincolong, No. 4834 (Bohol), 1981, 1982 (Misamis, Mindanao).

Citrus micrantha var. *microcarpa*. SAMUYAO.

(Pl. VII*b*.)

A shrubby tree, 4.5 meters tall, with slender branches and small, weak spines; leaves 55 to 80 millimeters long, 20 to 25 millimeters broad, ovate to ovate-oblong or elliptical, crenulate, thin, of distinct fragrance, base rounded to broadly acute; apex obtuse, sometimes notched, petioles 20 to 30 millimeters long, broadly winged, about 14 millimeters wide, wing area somewhat less than one-half of the leaf blade; flowers in compact axillary or terminal cymes, 2 to 7, small, 5 to 9 millimeters in diameter, white, with trace of purple on the outside; calyx small, not cupped, petals 3 to 5; stamens 15 to 18, free, equal; ovary very small, globose to obovate; locules 7 to 9, style distinct; stigma small, knob like; fruit 15 to 20 millimeters in diameter, roundish in outline; base sometimes nippled; apex an irregular, wrinkly cavity; surface corrugate, greenish lemon yellow; oil cells usually sunken; skin very thin; pulp fairly juicy, acid, bitter with distinct aroma; juice cells very minute, blunt, containing a small, greenish nucleus; seeds small, flattened, sometimes beaked.

The samuyao occurs sparingly in cultivation in Cebu and Bohol. Flowers were collected in May, partly grown fruits were also obtained, and ripe fruits have been collected in June, and from November to February, showing that the plant is more

or less everbearing. The fruit is used by the Filipinos as a hair wash, and is of no economic importance.

Throughout, the samuyao gives an impression of dwarfness, by its small size, weak spines, small, and thin leaves; the flowers are even smaller than in the biasong and the fruit is in all probability the smallest in the genus.

In Bohol a somewhat more vigorous variety of samuyao was found which is named "samuyao-sa-amoo." The fruits of samuyao-sa-amoo are a little larger, and smoother, and longer than broad, otherwise similar to the samuyao.

Samuyao, B. A. No. 2371, 2509 (Cebu), 2530, 4821 (Bohol); Samuyao-sa-amoo 2533, 4832 (Bohol).

Citrus medica L. CITRON.

A shrub or small tree, about 3 meters high, with a short, indistinct trunk and short, thick, irregular, straggling, thorny branches; bark light gray; thorns short, sharp, rather stout; young shoots smooth, violet colored or purplish, stiff; leaves large, 10 to 15 centimeters long, oval oblong, serrate or somewhat crenate, dark green above, lighter beneath; flowers small, axillary, in compact clusters of 3 to 10, often uninsexual; calyx small, cupped; corolla white within, tinged with purple on the outside; petals oblong, the tips incurved; stamens short, irregular in length, 40 to 45 in number; pistil small;[1] ovary 9 to 12 loculed or occasionally more; fruit lemon yellow, large, 15 to 22 centimeters long, oblong, rough or warty, sometimes ridged; apex blunt pointed; rind thick, white, except for the outer colored rim; pulp sparse; juice scant, acid, and somewhat bitter or sweetish; juice sacs small, slender; seeds oval, plump, light colored, smooth. Probably native to India, or it may have been introduced there from farther east, China or Cochin China. Extremely sensitive to cold.

The citron is the rarest of all the old cultivated citrus in the Philippines and is very seldom seen in the markets.

Citrus medica var. *odorata*. TIHI-TIHI.

(Pl. VII*a*.)

A small, thorny shrub, seldom exceeding 2.5 meters in height, with sharp, stout spines; young growth bright green; leaves 7.5 to 11 centimeters long, 4.3 to 6.5 centimeters broad, elliptical, rather thick and leathery, serrate, of distinct fragrance; base rounded; apex notched; petioles very short 4 to 6 millimeters long, not winged; flowers 1 to 4 in axillary compressed cymes, sessile, rarely exceeding 38 millimeters in diameter; calyx large, prominently cupped; petals 4 to 5, fleshy, white, with a tinge of purple on the outside; stamens 36 to 42, unequal, shorter than stigma; filaments united in groups of 4 to 6; pollen abundant; gynoe-

[1] In the above description the pistil is said to be small. Citron flowers examined by the writer have been found to have large pistils similar to those in *C. m.* var. *odorata* and *C. m.* var. *nanus*.

cium frequently aborted; ovary elevated on a bright green disk, large, 4 millimeters long, 13 to 14 loculed; style tapering from ovary, scarcely more slender, rather short; stigma large, knob like, and cleft; fruit 60 to 65 millimeters long, 7 to 10 centimeters in transverse diameter, weighing 300 to 475 grams, oblate, with a shallow basal cavity, and sometimes a mammilate apex, more or less ridged longitudinally, fairly smooth, clear lemon yellow; lenticels scattered, depressed; oil cells large, equal or a trifle raised; skin rather thick; pulp grayish, rather dry, sharply acid, of lemon flavor; juice cells long and slender; seeds many—sometimes 125 in a single fruit—short, broad, and flattened.

The tihi-tihi is a rare plant found in cultivation in Cebu and Bohol; one plant has been seen in Misamis, Mindanao. The plant is very precocious, fruiting as early as the third year from seed, everbearing, and is used by the Filipinos in washing the hair. It is not eaten, and is of no commercial importance.

The tihi-tihi differs from the citron in its green, tender, highly aromatic growth, the leaves having been found to contain 0.6 per cent essential oil as analyzed by the Bureau of Science. The fruit is strikingly different from the citron.

B. A. No. 19 (Cebu).

Citrus medica var. *nanus*.

A small, thorny shrub, rarely exceeding 2 meters in height, with small, sharp spines; leaves 7 to 11 centimeters long, 2.5 to 4.5 centimeters broad, narrowly oblong ovate to elliptical oblong, serrate, darker above than beneath; base rounded; apex frequently notched; petiole 5 to 7 millimeters long, wingless; flowers 2 to 10, in axillary or terminal, rather loose cymes, 3 to 4 centimeters in diameter; calyx large, cupped; petals linear oblong, with tips slightly incurved, white, with trace of purple on the outside; stamens 36 to 50, unequal; filaments usually united into groups, sometimes free; gynoecium sometimes wanting; ovary large, oblong, 10 to 12 loculed; style not distinct, of nearly the same thickness as ovary; stigma large, superior to anthers, knob shaped; fruit 65 or more millimeters long, 55 millimeters in diameter, ellipsoid to almost roundish, pointed at apex, lemon yellow, smooth; rind medium thick; pulp grayish to greenish, acid, rather dry; juice cells long and slender, almost linear; seeds many, rather small, flattened, smooth.

The plant is rather common in the Archipelago, and has been noted in Tarlac, Pampanga, Bulacan, Laguna, and Cebu. It is frequently grown and fruited in small pots, and is probably the smallest species in the genus. It is surprisingly productive and precocious, fruiting as early as the second year from seed, and is practically everbearing. The fruit is eaten by the Filipinos but is too dry to be cultivated for the flesh and the skin is too thin for utilization as citron peel.

B. A. No. 27 (Cebu), 2384 (Laguna).

Citrus limonum Risso. LEMON.

A small tree 3 to 6 meters in height, with rather open head of short, round or angular branches, thorny; bark grayish; young shoots purplish, smooth; leaves evergreen, alternate, 50 to 75 millimeters in length, ovate oval, sharp pointed, light green, margin serrate; petioles entirely wingless; flowers solitary, occasionally in pairs, axillary, on distinct peduncles; calyx persistent, segments 4 or 5; corolla large, 38 to 50 millimeters across, white inside, purplish outside; petals oblong, spreading, strongly reflexed; stamens 20 to 26, separate, or more or less united in small groups; ovary considerably elevated on a prominent disk, 7 to 10 loculed; fruit ripening at all seasons, ovoid or oblong, and pointed at both base and apex, about 75 millimeters long, smooth or rough, light yellow in color; rind thin, flesh light colored; pulp acid; juice sacs long and pointed; seeds oval, pointed at the micropylar end, quite smooth. Native of the same regions as the citron.

The true lemon is very rarely cultivated in the Philippines and all lemons used are imported from California, Australia and Spain.

Citrus pseudolimonum. COLO-COLO.

(Pl. VII*a*.)

A thorny shrub, 3 meters tall, with interlocking branches, and short, sharp spines; leaves 8 to 11 centimeters long, 40 to 45 millimeters broad, elliptical to oblong-ovate, crenulate to serrulate; base rounded; apex obtuse, frequently slightly notched; petioles 18 to 25 millimeters long, with narrow wing margin, rarely exceeding 10 millimeters in width; flowers 1 to 5, in terminal or axillary short cymes, 28 to 35 millimeters in diameter, white, purplish outside; calyx cupped; stamens 30 to 37, nearly always free, unequal; ovary broadly obovoid, 14 to 18 loculed; style distinct; fruit roundish to pyriform, small, usually compressed at base; apex irregular; surface greenish lemon, more or less corrugate; oil cells raised; skin comparatively thick; pulp acid; juice cells small, short and plump; seeds undeveloped and sterile.

The colo-colo is another of these peculiar Philippine species with more or less winged petioles affiliated to the lemon, etc. Flowers were collected in May, and ripe fruit has been examined in January and February. The nearly always free stamens in a plant belonging to the same general group as the lemon is of interest.

Near the colo-colo is the "lombog," considered a distinct fruit, also found in Bohol. This variety is less vigorous than the colo-colo and also differs from the plant in having narrower wing margins and 21 to 28 stamens and 9 to 11 locules. The fruit is said to be about 4.5 centimeters in diameter and similar in shape to that of the colo-colo.

The "kunot" is a third variety considered distinct by the Boholanos that also may be referred to *C. pseudolimonum.*

To *C. pseudolimonum* may perhaps also be referred a thorny, arborescent shrub, attaining a height of 4.5 meters, found in Siquijor, a little island south of Negros. Material of this was collected in August, 1912, by the writer, at which time the tree bore partly grown, oblong, rough, small fruits. The plants at Lamao have flowered during the last two months but have not set fruit. The principal difference in this variety from the colo-colo and lombog is in the number of stamens, here 36 to 41.

The fruits of *C. pseudolimonum* have no economic value.

Colo-colo, B. A. No. 2535, 4825; Lombog, No. 2498, 4827 (Bohol), 1953 (Siquijor).

Citrus limetta Risso. LIME.

A shrub or tree of straggling habit, with small, stiff interlocking or drooping, thorny branches, the thorns small, sharp, numerous; bark grayish brown; young branchlets light green, becoming darker with age; leaves elliptic-oval, glossy green in color, margin slightly indented; petioles margined; flowers small, produced in axillary clusters of 3 to 10; calyx small, four to five pointed; corolla white on both inner and outer surfaces; petals 4 to 5, oblong, fleshy; stamens small, 20 to 25, united in a number of groups; ovary about 10 loculed; fruit rounded or oblong, frequently mammilate, light yellow; rind thin; pulp greenish, acid; juice sacs small, slender, pointed; seeds small, oval, pointed. Native to India and southeastern Asia.

The lime, in Luzon known as "dayap," ranks third in importance among the citrus fruits cultivated in the Philippines, and now and then excellent fruit is found in the market, showing what could be done in grwing first-class fruit if pains were taken to do a little selection work and plant budded trees.

Citrus limetta var. *aromatica.*

A spiny shrub, with rather slender, willowly, drooping branches, and sharp spines; young growth light green, of pleasant and distinct odor when bruised; leaves 7.5 to 10 centimeters long, 3.5 to 5 centimeters broad, ovate oblong to elliptical, serrate to crenate, dull green above; base rounded to broadly acute; apex frequently notched; petiole 6 to 19 millimeters long with a narrow wing margin; flowers solitary or in cymes to 4, terminal or axillary, 28 to 35 millimeters across; calyx rather large, cupped; petals 4 to 5, white with a trace of purple on the outside; stamens unequal, 28 to 32, more or less united; ovary large, oblong, 12 to 13 loculed; style not distinct as in *C. aurantium* but rather similar to that in *C. medica,* a trifle more slender than the ovary; fruit 5 centimeters long, 4 to 4.5 centimeters across, roundish to roundish oblong, lemon yellow, smooth; skin thin; pulp pale green, juicy, sharply acid, sometimes almost bitter; juice cells long, slender and pointed; seeds very numerous, small and plump, polyembryonic.

This form seems to be fairly well distributed and material has been propagated at Lamao from such distinct points as Mindoro, Palawan and Benguet. Unquestionably a lime, it is quite distinct from the ordinary lime in habit, and in the aromatic tender foliage and purplish-petaled flowers on the outside, which are larger than those in the lime, the number of stamens also exceeding those of the lime.

B. A. No. 741 (Palawan), 1749 (Mindoro), 2182 (Benguet).

Citrus excelsa. LIMON REAL.

A thorny, tall shrub of vigorous growth, straggly habit and interlocking branches, with stout, long, sharp thorns; young growth purplish; leaves 9.5 to 16 centimeters long, 4.5 to 7 centimeters wide, elliptical oblong to ovate oblong, crenate to serrate, thick and leathery; base rounded; apex retuse; petiole 19 to 37 millimeters long, quite broadly winged, in large leaves the wings frequently exceding 2 centimeters in width; flowers 3 to 7, in axillary, rather loose cymes, 36 millimeters in diameter; calyx medium large, cupulate; petals showing trace of purple on the outside; stamens 34 to 35, unequal; filaments occasionally free, usually united into groups of 2 to 6; ovary roundish, 10 to 14 loculed, 4.5 millimeters across; style distinct, 5 millimeters long; stigma large; fruit 5 to 7.3 centimeters long, 5.5 to 7.5 centimeters in equatorial diameter, weight 115 to 225 grams; form subglobose; base rounded; apex flattened; surface smooth, greenish to clear lemon yellow; skin thin; pulp greenish to grayish, in good varieties very juicy, mildy acid, and of excellent flavor; juice cells long, slender and pointed.

Plant material of the limon real has been collected in Tarlac, Bontoc, and Bohol, and the fruit is at rare intervals offered for sale in small quantities in Manila.

The name of the plant, "Royal lemon," indicates the esteem in which the fruit is held by the people, and while it is unfortunately true that most fruits tested have been too dry to be of any value, yet in the best types the fruits in quality and aroma surpass all lemons and limes that the writer has had the opportunity to sample. With its robust, thorny growth, large leaves and broad-winged petioles and considering its affinity to the lime and lemon together with the roundish oblate fruit with 34 to 35 stamens as against the 20 to 26 in those species and with its 10 to 14 locules, this plant is apparently as distinct from the lemon and lime as these species are from each other.

B. A. No. 1727 (Bontoc?).

Citrus excelsa var. *davaoensis.*

A thorny, arborescent shrub of straggly habit, with interlocking, drooping branches, and of vigorous growth; young growth green with tinge of purple; leaves 8.5 to 13.5 centimeters long, 3.8 to 5 centimeters wide, ovate to oblong ovate, crenulate to serrulate; base rounded; apex some-

times retuse; petiole 16 to 30 millimeters long, with wings ordinarily narrow, in large leaves sometimes 15 millimeters wide; flowers not seen; fruit 6.4 centimeters long, 8 centimeters in equatorial diameter, weighing 317 grams, oblate; base rounded; apex flattened to depressed, wrinkled, with a circular depression around the raised stigmatic area; surface otherwise fairly smooth, lemon yellow; skin thin, central cavity large; pulp contained in about 13 locules, light colored, quite juicy, sharply acid, and of good flavor; juice cells long and slender.

Ripe fruit of this species has been received from Davao, Mindanao, in December and January. The fruit is perhaps too large for retail trade, but might possibly be utilized in the manufacture of lime juice and allied products.

Full-grown plants of *C. excelsa* or the variety above described have not been seen, but *C. e. davaoensis* appears to be smaller than *C. excelsa* in all respects, the fruits excepted. There has been no opportunity for an examination of the flowers but so far as observed the plant appears more closely related to *C. excelsa* than any other species herein described.

B. A. No. 1009 (Davao, Mindanao).

ECONOMIC VALUE OF THE NEW OR LITTLE KNOWN SPECIES.

The horticulturist and plantbreeder, ever on the alert for new plant material that may enhance his profits, extend the cultivable area of his crop, or be used in making new cross combinations, will naturally ask himself of what value are these new plants and fruits. Briefly stated, it may be said that the "Tizon" is a dessert or breakfast fruit of high, if not perhaps the highest, order, its main defect being the unsightly basal projection. Then, as stated elsewhere, the best "limon real" is unsurpassed in quality for "ade" making. Perhaps third in importance are the better types of the alsem for the manufacture of citric acid, etc., and it might find a sale in competition with the lemon and lime, depending to a great extent upon its keeping qualities. The juicy, thin-skinned, and few-seeded talamisan may find lovers as a breakfast fruit and is also of the right size for an ade fruit. If cultivation would increase the juiceness of the panuban, this fruit may find favor with many. A good marmalade may be made of the calamondin. The above species or varieties have more or less of a future on account of their pomological merits, and the plant breeder, by crossing them and the cabuyao and canci with old cultivated species, might obtain valuable results.

There is also the prospective value of the new species as stocks. To determine the congeniality of these species and the

old cultivated citrus fruits and their value as stocks under various soil conditions would of course require the labor and close observations of many years.

The calamondin is quite drought resistant and would probably dwarf the scion. One year old buds of the pomelo, lime, mandarin and orange at Lamao have made satisfactory growth, the buds taking without difficulty. The cabuyao is a very vigorous tree and is also drought resistant. It has recently been budded with the cultivated citrus fruits, the buds "taking" very well. The orange has been budded on the alsem, resulting in a good growth, being now (December, 1914) nine months old. During the trip to Bohol in May, the limao, growing in a coraline lime-stone formation overlaid with a little humus, the exact counterpart of the Bahama Islands or the "hammock lands" in southeast Florida, impressed the writer as one of the best examples of drought resistance among citrus fruits under such conditions. The talamisan also appeared quite drought resistant, and is furthermore of value as a live fence because of its large spines.

The "limon real" is of great vigor and hence may be a desirable stock for certain varieties and under certain conditions.

BY-PRODUCTS OF SUGAR MANUFACTURE.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

In various lines of manufacturing there are certain by-products which, years ago, constituted a waste and great loss, but which now under modern methods have become in many cases of considerable importance.

This is especially true with the sugar industry. Extreme care and attention is required to keep the balance on the right side of the ledger, and often the proper handling of the by-products forms the deciding factor between success and failure. In order to build up a great sugar industry in these Islands, more attention must be given to the details of the work, and many of the present losses must be turned into profits before great progress can be expected.

CANE TOPS AND TRASH.

First in the series of by-products in the manufacture of sugar, comes cane tops. The amount of this material produced per hectare will depend upon various factors, including the variety of cane, its stage of maturity, etc. The less of these tops, of course, that may be produced for a given amount of cane, the better it will be for the growers, nevertheless they have a good feeding value if properly handled.

Professor Dodson,[1] director of the Louisiana Experiment Station, states that he found cane tops to have the following composition:

	Per cent.
Protein	1.53
Fat	0.41
Carbohydrate	15.62
Fiber	8.87
Water	71.50
Ash	2.07

The fiber content would be slightly higher and the water content lower, for tropical cane, since maturity is completely

[1] Paper read before the Louisiana Sugar Planters Assn., June 12, 1913.

reached before harvest begins. It may be seen from the above analyses that this makes a most excellent feed for work animals. Certainly greater advantage should be taken of this feeding stuff than is usually done, since there is a scarcity of pasturage near the end of the harvest season and the animals become needlessly thin on account of lack of feed. At present very little of this material is utilized, but instead is burned on the field with the rest of the trash. If the tops are removed and used as a stock feed, only the leaves and pieces of stalk remain, and these make a good fertilizer for cane lands.

It is the general custom in these Islands to burn all of this material as soon as the crop is harvested. The object of this burning is to destroy any insects that may be present, as well as to facilitate subsequent cultivation. In the writer's opinion neither of these reasons is sufficiently well based, since in this country large numbers of troublesome cane insects are not found. If they were present in sufficient quantities, the trouble could be handled by placing the trash between the rows and properly treating it before plowing it under. This should be the method of disposing of the trash at all times. In this manner the waste material could be utilized, and the organic matter would be even more valuable than that contained in many of the commercial fertilizers. The nitrogen contained, which amounts to from 0.5 to 2 per cent, would be practically all saved, while with the burning method this is completely lost.

In Louisiana, cotton-seed meal forms one of the principal nitrogenous fertilizers for cane lands. This material costs from ₱50 to ₱75 per ton and Dr. Stubbs,[1] in his research, found that the trash burned from each ton of cane caused a loss of nitrogen equal to that contained in 27 pounds of cotton-seed meal. Besides this loss of nitrogen encountered in the burning of the trash, the organic matter which would later form humus is completely destroyed. Soils would retain moisture better during the dry season and be more easily handled if the conservation of organic matter were given greater attention. There is also a great injury done to the remaining stumps and top roots by this burning which is very detrimental when the field is to be used for a ratoon crop. Where cane is badly infested with destructive insects, it is quite another thing. This again brings up the fact that the cane points should be treated with chemicals before planting, in order to complete the work of destroying these insects.

[1] Cultivation of Sugar Cane, by Dr. Stubbs.

USE OF ASHES.

The ash of sugar cane constitutes the mineral matter that has been taken out of the soil. This usually runs about 0.48 per cent of the total weight, according to Payson's classical analyses. Chemically this contains the following: silica, iron, aluminum, lime, magnesia, potash, sodium, phosphorus, sulphur, chlorine, oxygen, water, etc. Of these various elements, the phosphorus and potash are the most valuable to the planter. Lime is also useful for many soils in correcting the acidity, and occasionally in supplying that element, when it happens to be lacking in a particular soil.

The cost of different fertilizers is governed by the percentage of these plant-food elements contained. Phosphoric acid is worth $0.05 per pound (₱0.22 per kilo) in crude fertilizers. At this rate the value of this element recovered from a crop of 75 tons of cane per hectare would be from ₱10 to ₱12.

Potash is valued at about ₱0.26 per kilo and that removed with a crop of 75 tons would cost about ₱25. The lime contained is a cheaper element but will not act as a detriment on any soil, while on many it will be found very helpful.

In spite of the great deficiency in these elements in the cane lands here, and the high cost of commercial fertilizers, this waste material is not only neglected at the majority of the factories but is actually thrown away, yet the same elements that command a high price in commercial fertilizers are contained in these ashes.

FILTER-PRESS REFUSE.

In the defecation of cane juice, certain chemicals are often used to precipitate the impurities, which are removed from the subsiders after the clear juice has been drawn off, and sent to the filter presses, where it is filtered through heavy cloths. This material contains coarse particles of bagasse together with other impurities including the lime and phosphoric acid which were used in this work. The composition of the material depends upon the original composition of the juice and the amount of the different chemicals that has been used in the clarification. In any event, it makes a most valuable fertilizer because of the organic matter, nitrogenous bodies, phosphoric acid, and lime that it contains. This organic material is an ideal substance to be applied to the worn-out cane lands (which consist almost entirely of mineral substances) since it induces bacterial action, and during its decomposition certain acids are freed, such as

carbonic, nitric, and organic acids. These have the power to act upon the mineral constituents and thus liberate other plant-food elements. The filter-press mud can very well be mixed with the bagasse ashes, and scattered about the cane rows as an almost complete fertilizer for sugar cane, the only element lacking being nitrogen, which was lost in the burning of the bagasse.

It will be remembered that in the synthesis of sucrose, which consists of carbon, hydrogen, and oxygen, there are none of the plant-food elements used which are sought for in commercial fertilizers. These are used only in building the fibrous stalk of the cane and they may all be recovered in the bagasse and cane-juice impurities. The carbon, hydrogen, and oxygen which are used practically all come from the air and water.

It is a custom to-day to cart this ash to piles or depressions some distance from the factory. In some places it is thrown into the river, or cast into the sea—an absolute loss.

Planters must not depend upon commercial fertilizers for their supply of plant-food material, when there is such an abundance of natural fertilizer being wasted. The cost of the artificial fertilizers in many cases is considered prohibitive and often unnecessary. In order to build up a great sugar industry here, the material at hand must be used, while money should be spent for modern apparatus and equipment.

MOLASSES.

The dark-colored viscous substance remaining after the large crystals of sucrose have been removed is called molasses. This contains small crystals of sucrose, which has passed through the perforations of the centrifugal screens, sucrose in solution, glucose, fructose, and other organic substances, such as pectin bodies, albumenoids, coloring substances, etc., besides the inorganic matter constituting the ash upon incineration of the molasses.

The composition of the molasses varies with the working of each factory, also with the condition of cane, time of harvest, etc. The juice from green cane and that which has reached ultramaturity will contain a higher percentage of invert sugar and organic non-sugars than a properly matured cane. Then factories that have ample boiling-house provision, and crystallizers as well as magma tanks, will be able to send out a molasses with lower purity, thus recovering more of the crystallizable sugar.

In any case there will be some molasses produced, and this constitutes a valuable sugar-house by-product, if properly cared for. It may be disposed of in one of several forms, namely, as a human food, a stock feed, a source of alcohol, factory fuel, and a fertilizer.

Cane molasses as a human food.—For many years low-grade cane molasses has been used as a human food in the United States. It was originally sold under the name of New Orleans molasses, but in recent years a number of companies have employed clarifying and bleaching agents and thus turned out a very fancy article, under various trade names, for baking purposes. With the boiling at low temperatures practiced to-day, there is little or no caramel formed during this work, and consequently it is only necessary to clarify and bleach the organic nonsugars, in order to make a salable molasses. The bleaching is usually accomplished by the use of a hydrosulphite, either in the form of sodium or calcium, but sometimes only the sulphurous acid gas is used.

The bleaching effect of none of these reagents is permanent, especially when the product is exposed to the air and light. Such chemicals must therefore be used with great caution, and as late in the process as possible. Care must be exercised too that an excessive amount is not employed, since an undesirable tint is liable to result as well as an excessive amount of the sulphites to be admitted, which is not permitted by the Pure-Food Law. It is astonishing how much of this low-grade molasses is thus manufactured and used in the United States for cooking purposes, and what a high price this product commands.

Cane molasses as a stock feed.—Perhaps more of the exhausted molasses is used for this purpose in these Islands than for any other.

Ordinary molasses contains from 30 to 35 per cent of sucrose and almost as much glucose. These being purely carbohydrates, it is necessary to combine them with some protein-bearing feed in order to make a perfect ration. Many leguminous plants, such as alfalfa, cowpeas, peanut vines, etc., may be cut fine and used as an absorbent for molasses. This makes a most excellent feed as it contains a sufficient amount of roughage, and at the same time offers a balanced ration if properly composed. In this country there is a great amount of exhausted cake from the coconut-oil factories, which is exported to Europe each year. There is no good reason why this should not be used as an absorbent for the molasses in making a concentrated feed, which

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could be transported to various parts of the Islands or exported abroad for stock.

To-day the Philippines are dependent upon Australia and other countries for many thousand head of cattle each year. The by-products from sugar factories are thrown into the rivers or flushed away from the factories through drains, and the leaves and tops of the cane are burned on the ground in order to facilitate cultivation. In the attempt to grow our own beef, these feeds should be an important factor.

Cane molasses as a source of alcohol.—Alcohol can be made from a great variety of substances containing the necessary constituents, viz, carbon, hydrogen, and oxygen.

Of the numerous alcohols possible, ethyl alcohol is the one ordinarily sought and the easiest produced. This alcohol is represented by the following chemical formula: C_2H_5-OH.

While glucose is the substance which may be easily transferred into alcohol by fermentation, sucrose may also be used, providing it is first changed into glucose or invert sugar. Even cellulose and starch may be used after being transferred into reducing sugars.

The process of changing glucose into alcohol and carbon dioxide is called fermentation and is accomplished by a minute organism. Sucrose will not directly ferment, consequently it must first be changed into glucose. This is usually accomplished by an enzyme which is secreted by a ferment.

The following chemical formula will serve to show the steps necessary to pass from sugar to an alcohol:

$$\underset{342\ \text{M. W.}}{C_{12}H_{22}O_{11}\ (\text{sucrose})} + H_2O\ (\text{water})\ \ \text{Presence of an enzyme} \xrightarrow{\text{Invert sugar}} \left(\underset{180\ \text{M. W.}}{C_6H_{12}O_6\ (\text{dextrose})}\ \ \underset{180\ \text{M. W.}}{C_6H_{12}O_6\ (\text{levulose})}\right)$$

$$\rightarrow \underset{184\ (2\ \text{M. W.})}{C_2H_5\text{–}OH\ (\text{ethyl alcohol})} + \underset{176\ \text{CM. W.}}{4CO_2\ (\text{carbon dioxide})}$$

The theoretical yield then of alcohol from sucrose would be 53 per cent and from invert sugar 51 per cent. In practice, however, this yield would not be experienced on account of the yeast converting some of the sugars into substances other than alcohol and carbon dioxide. These will consist mostly of glycerine and succinic acid and will amount to 4 or 5 per cent.

Since the working conditions determine to a very great extent

the yield of alcohol, it is obvious that a thoroughly efficient person should be in charge of this work. In the selecting of cultures for the fermenting, the manufacturer should use only the purest, otherwise acetic acid and other foreign substances will be formed during fermentation, thus decreasing the yield of the alcohol as well as lowering its purity.

Where the percentage of sucrose and glucose of a molasses is known, it is a simple matter to calculate the theoretical amount of alcohol to be recovered and by knowing the efficiency of the factory, a factor may be obtained which multiplied by the theoretical yield will give the true amount of alcohol to be expected. In this manner it is easy to determine the price that may be paid for any molasses.

The separation of the alcohol from the water and dirt (lees) is accomplished in an apparatus termed a "still." In this the liquor is heated by steam which causes the alcohol to evaporate. Since ethyl alcohol boils at a temperature of 78° or a little higher, depending upon the percentage present, it may be separated from the water and impurities during the evaporation, and recovered from the coils of the condenser in a fairly pure state.

There is always, however, more or less water vapor escaping with the alcohol and consequently it is impossible to secure absolute alcohol without after-treatment, although in the modern still a very high grade is often recovered in the first distillation.

In this connection the strength of alcohol is usually determined by referring it to "proof," which is an old English system used before modern methods of testing spirits were available. In its original application, gunpowder was moistened with the spirit and the mixture subjected to the flame of a match. When just enough alcohol was present to set fire to the powder, it was said to be "proof spirit." If not enough alcohol was present to accomplish this, it was said to be "under proof," and when the gunpowder was lighted easily by it, it was said to be "over proof."

By an act of the English Parliament, the term "proof spirit" was fixed as one which contains exactly $^{12}/_{13}$ of an equal volume of water (distilled) at 51° F., which represents 57.1 per cent of alcohol by volume, or 49.3 per cent by weight.

The simplest method of determining the percentage of alcohol is by the use of a gravity spindle for liquids lighter than water, and by referring to the accompanying table for this purpose, the percentage of alcohol may be ascertained.

Table for calculating the percentage of alcohol.[a]

Volume.	Specific gravity at— $\frac{15.56^\circ}{15.56}$	Specific gravity at— $\frac{25^\circ}{15.56}$	Volume.	Specific gravity at— $\frac{15.56^\circ}{15.56}$	Specific gravity at— $\frac{25^\circ}{15.56}$	Volume.	Specific gravity at— $\frac{15.56^\circ}{15.56}$	Specific gravity at— $\frac{25^\circ}{15.56}$	Volume.	Specific gravity at— $\frac{15.56^\circ}{15.56}$	Specific gravity at— $\frac{25^\circ}{15.56}$
P. ct.			*P. ct.*			*P. ct.*			*P. ct.*		
1	0.9985	0.9970	26	0.9698	0.9655	51	0.9323	0.9246	76	0.8745	0.8665
2	.9970	.9953	27	.9691	.9646	52	.9303	.9226	77	.8721	.8641
3	.9956	.9938	28	.9678	.9631	53	.9283	.9205	78	.8696	.8616
4	.9942	.9922	29	.9665	.9617	54	.9262	.9184	79	.8664	.8583
5	.9930	.9909	30	.9652	.9603	55	.9242	.9164	80	.8639	.8558
6	.9914	.9893	31	.9643	.9594	56	.9221	.9143	81	.8611	.8530
7	.9898	.9876	32	.9631	.9582	57	.9200	.9122	82	.8581	.8500
8	.9890	.9868	33	.9618	.9567	58	.9178	.9100	83	.8557	.8476
9	.9878	.9855	34	.9609	.9556	59	.9160	.9081	84	.8526	.8444
10	.9869	.9846	35	.9593	.9538	60	.9135	.9056	85	.8496	.8414
11	.9855	.9831	36	.9578	.9521	61	.9113	.9034	86	.8466	.8384
12	.9841	.9816	37	.9565	.9507	62	.9090	.9011	87	.8434	.8352
13	.9828	.9801	38	.9550	.9489	63	.9069	.8989	88	.8408	.8326
14	.9821	.9793	39	.9535	.9473	64	.9047	.8969	89	.8373	.8291
15	.9815	.9787	40	.9519	.9456	65	.9025	.8947	90	.8340	.8258
16	.9802	.9773	41	.9503	.9438	66	.9001	.8923	91	.8305	.8223
17	.9789	.9759	42	.9490	.9424	67	.8973	.8895	92	.8272	.8191
18	.9778	.9746	43	.9470	.9402	68	.8949	.8870	93	.8237	.8156
19	.9766	.9733	44	.9452	.9382	69	.8925	.8846	94	.8199	.8118
20	.9760	.9726	45	.9434	.9363	70	.8900	.8821	95	.8164	.8083
21	.9753	.9719	46	.9416	.9343	71	.8875	.8796	96	.8125	.8044
22	.9741	.9706	47	.9396	.9323	72	.8850	.8771	97	.8084	.8003
23	.9728	.9692	48	.9381	.9307	73	.8825	.8746	98	.8041	.7960
24	.9716	.9678	49	.9362	.9288	74	.8799	.8719	99	.7995	.7914
25	.9709	.9668	50	.9343	.9267	75	.8769	.8689	100	.7964	.7865

[a] From United States Department of Agriculture Bulletin, No. 107, p. 203.

Molasses as a fuel.—Many experiments have been made, using this substance as a sugar-house fuel, and while ordinarily it may be better employed in some other manner, at the same time where no other provision is made for the use of this material, and where there is a scarcity of fuel as well, satisfactory results may be secured in its combustion if it is properly handled.

Waste molasses consists mainly of gums, sucrose, glucose, albuminoids, other organic compounds, water, and a small amount of ash.

Sucrose has the chemical formula of carbon 12 (atoms), hydrogen 22 (atoms), and oxygen 11 (atoms). The burning of carbon consists in uniting oxygen to that element, forming carbon dioxide. When hydrogen burns, the oxygen combines with it, forming water. During this oxidation, two atoms of hydrogen combine with one of oxygen, but in the molecule of sugar, these two elements are already present in this proportion, consequently only the carbon may be oxidized and thus give off heat. This is found to be true also of sucrose, reducing sugars, and many organic compounds.

An instrument called a calorimeter is used to determine the

amount of heat a substance will give off upon oxidation. Tests may be made on molasses in order to determine its value as a fuel, and thus a comparison may be obtained of a pound of this material and one of coal having a standard value.

The ash from the molasses contains a great deal of potassium and some magnesium, consequently care must be exercised in the burning of the molasses so that this material does not come in direct contact with the tubes of the boiler, since a heavy coating will be formed that will greatly lower the coefficient of heat transmission.

On account of the high potash content, these ashes make a valuable fertilizer, which should be mixed with the bagasse ashes and mud cake, and applied to the cane lands.

Molasses as a fertilizer.—While molasses is not used to any great extent as a fertilizer, there is no good reason why exhaustive experiments should not be carried out with this by-product on Philippine soils, when it is now being thrown into drains or wasted, until a better use is provided for the molasses.

Experiments have been made in Hawaii, Mauritius, and other places with this form of fertilizer, and very encouraging results were reported. The plant-food elements themselves contained in molasses are small in amount, since they are contained in the low percentage of ash after burning, except, of course, nitrogen, which will be entirely saved. Its main value, however, lies in the power to induce bacterial growth, which is so necessary in worn-out soils.

Among the organisms induced by these organic matters may be included certain azotobacter species, which contrary to other forms of plant life, have the power of using nitrogen from the air. Carbohydrates form especially good mediums for their development, and it has been found that the activities of these organisms are increased by an increased amount of this substance.

While excellent results have been attained by the use of low-grade molasses for fertilizer in other countries yet it remains for the planters here to determine results under Philippine conditions, and the best method of handling their material. In some places where irrigation water is applied, the molasses is mixed with the water and applied in the usual manner.

The plant-food material contained in molasses will vary somewhat with the methods of its production, clarifying agents previously used, etc.

The following table will indicate the composition of ash from different molasses:[1]

	1	2	3	4
	Mill sulphitation.	Diffusion sulphitation.	Open kettle.	Carbonitation.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Potash	49.48	52.20	51.48	50.16
Soda	.89	.80	1.11	.32
Lime	6.47	6.78	6.58	8.53
Magnesia	4.29	3.09	3.99	2.66
Iron oxide	.35	.33	.15	.47
Alumina	.30	.22	.13	.30
Silica	4.12	4.59	2.83	4.10
Phosphoric acid	3.71	3.80	2.12	.91
Sulphuric acid	10.79	6.72	10.94	11.18
Carbonic acid	7.49	11.19	13.06	15.78
Chlorine	14.00	11.95	9.10	4.59
	101.89	101.67	101.49	99.00
Deduct O minus Cl.	3.16	2.70	2.05	1.04
	98.73	98.97	99.44	97.96
Undetermined (carbon, etc.)	1.27	1.03	0.56	2.04
Alkalinity (cc. tenth normal per gram ash) cc.	80	93	95	109

In order to make a wise selection of the method of handling the different by-products the manufacturer must take into consideration many factors. Among them will be the quantity of his output, the facilities for handling it in any specified manner, the demand for different finished products to be made therefrom, etc. All of these and many other points must receive due consideration by a manager who expects to attain success in his work.

[1] Bulletin 91, Louisiana Sugar Experiment Station.

COFFEE IN THE PHILIPPINES.[1]

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

PRELIMINARY REMARKS.

While it cannot be said that the Philippines have ever grown coffee on a scale that made it an important factor in the world's market, yet, before the advent of the coffee blight, coffee growing, from a Philippine point of view, was an industry of considerable magnitude and unquestionably of great promise. However, in the Philippines as in other parts of the eastern Tropics, the blight destroyed the coffee industry, and while in the last few years previous to the appearance of the blight there was an average annual export of about 7,000 tons of coffee, valued at ₱4,000,000, in 1913 the Philippines produced only 113,031 kilograms of Arabian coffee with an average production of 174 kilograms per hectare, the coffee imports during the same period amounting to 1,138,781 kilograms, valued at ₱816,744. The leading coffee-producing provinces of the Archipelago were, during 1913, the Mountain, 42,066 kilograms; Moro, 31,040 kilograms; Nueva Vizcaya, 5,792 kilograms; and Batangas, 5,319 kilograms. Varying quantities of coffee, less than 5,000 kilograms in any one, were produced in each of the remaining provinces, excepting Agusan, Bataan, Batanes, Ilocos Sur, Leyte, Pampanga, and Surigao, where coffee is not grown.

From a study of the coffee situation in the Eastern Hemisphere it is evident that Arabian coffee will never again become of importance in this part of the world, including of course the Philippines. However, it seems that a satisfactory substitute has been discovered in the robusta coffee. This variety, while not immune to the blight, is so resistant to the effects thereof that

[1] All statistics, and much of the information that applies specifically to robusta coffee have been adapted from "Robusta and Some Allied Coffee Species" by Dr. C. J. J. Van Hall, of the department of agriculture, Buitenzorg, Java, published in the Agr. Bul. of the F. M. S., Vol. I: No. 7, 1913, and from a review of a series of articles on robusta coffee by Dr. E. Wildeman, in the Monthly Bul. of Agr. Intelligence, etc., Vol. IV: No. 4, 1913.

the disease ceases to affect the profits of the crop, or at least very slightly.

This and other reasons, which will be explained later, have resulted in the planting of robusta coffee on a very large scale in Java and adjacent Dutch possessions, and the reports relative to this variety are such as to recommend it to the serious consideration of Philippine planters. The present paper has been prepared with a view of meeting the almost daily requests that reach this Bureau for information on the subject of coffee, and particularly to give some information relative to the robusta coffee, with which practically all planters in the Archipelago are unfamiliar. It might perhaps be well to state that propagation, handling of the plants from the seed bed to the plantation, culture, etc., are the same for both Arabian and robusta coffee, except where so stated.

ARABIAN COFFEE.

The decrease in the cultivation of coffee and the present status thereof in the Philippines show conclusively that Arabian coffee cannot be profitably grown here below an altitude of 800 meters. At and above this elevation the climate is so favorable for the growth of the plant that when kept in good condition it is capable of resisting the attack of the blight sufficiently to yield a profitable crop. Nevertheless, the planting of Arabian coffee on a large scale is not recommended even here, because the disease is everywhere present, waiting for a favorable opportunity to spread, and a drought, typhoon, or in fact anything that would devitalize the plants, would be sure to render them liable to a severe attack that might wipe out an entire plantation or district.

It is true that Arabian coffee grows below an altitude of 800 meters; in fact, coffee bushes are found at sea level, but a prospective investor should always remember that there is a very great difference between being able to merely *grow* coffee and to *produce it in such quantities that its cultivation becomes profitable.* This cannot be done at a low elevation. It is perhaps well to state here that exhaustive experiments have so far failed to yield a fungicide or spray by which the coffee blight can be satisfactorily controlled in the field.

Everything considered then, only in certain districts of the Mountain Province and on the table lands of Mindanao may Arabian coffee be successfully and profitably cultivated to any considerable extent.

ROBUSTA COFFEE.

Robusta coffee in Java.—When the blight appeared in Java, coffee growing was one of the most important industries in that island, and after the plantations had been destroyed by the disease, the Dutch Government, having failed to control the blight by repressive measures, instituted investigations with a view of discovering a blight-resistant coffee, in the course of which work several species were introduced and tested. Among these were Liberian coffee (*Coffea liberica*) and robusta coffee, considered by Wildeman to be a variety of *Coffea canephora.*

Robusta coffee was discovered in the Belgian Congo, and seeds were sent to Brussels, Belgium, and propagated, where plants were first offered for sale in 1901. Some of these plants found their way to Java. Like most new introductions the robusta coffee was at first looked upon rather askance, but as its greater climatological range as compared with that of Arabian coffee, and its productivity, precocity, and resistance to the coffee blight (*Hemileia vastatrix*) became apparent, it rapidly gained popularity—so rapidly in fact that the Javanese coffee plantations today consist almost entirely of robusta coffee. The fact that in 1909 the total crop of robusta coffee was only 183,000 kilograms, and that in 1911 9,650,000 kilograms were produced, with an estimated yield of 16,000,000 kilograms for 1912, and that during the period from 1907 to 1911, 24,521,000 robusta coffee plants were planted, is ample proof of its popularity in the Dutch East Indies.

Introduction into the Philippines.—Robusta coffee has not been introduced into the Philippines to any extent. Bearing trees are reported from Basilan, near Zamboanga, and a few plants are also growing at the Lamao experiment station in Bataan. The latter are in good condition with no indication of blight.

Soil and climate.—Robusta grows well from sea level to an altitude of 1,000 meters, doing best at an elevation ranging from 450 to 750 meters.

Less particular than Arabian coffee, the robusta thrives well on both light and heavy soils provided they have the necessary fertility. However, good drainage is essential for a good growth and therefore robusta should not be planted on sticky and very heavy, water-holding soils. Poor and sandy soils should also be avoided. This variety is also somewhat sensitive to drought and should be planted only where the rainfall is fairly evenly distributed, and where the dry season is of comparatively short duration. Generally speaking, where the soil conditions are

favorable, the cacao, abacá, and coconut growing districts of the Archipelago are perhaps better adapted than other sections to the culture of robusta coffee.

CULTURE.

Propagation.—The place selected for seedbed and nursery should be well drained, with a loamy soil, the richer in humus the better. A light bamboo frame should be erected above the nursery plot about 2.5 meters high, and covered with grass or split bamboo to provide about half shade. The land should be spaded thoroughly to a depth of 30 centimeters, and all stones, roots, etc., removed. One meter is a convenient width for seed and plant beds.

The seeds should be sown broadcast, not too thick, covered with not more than 1 centimeter of earth, and then watered thoroughly. Hereafter the seedbed should be well watered from time to time whenever the soil appears dry. Frequent light sprinklings that do not allow the water to penetrate more than a few millimeters below the surface are harmful rather than beneficial both in the seedbed and the nursery, in that they encourage a shallow root formation.

As soon as the first leaves are fully expanded the seedlings should be transplanted to the nursery beds, which should be prepared like the seedbed. If the land is poor it is well to spade in a liberal quantity of well-decayed manure or compost. The plants should be taken up carefully, the taproot nipped off with the thumb nail, and then transplanted with the aid of a pointed stick or small dibber spacing them 10 to 15 centimeters apart each way. In doing this care should be taken that the roots are not doubled up in the hole and that the soil is well packed around them. More plants should never be removed at one time from the seedbed than can be conveniently transplanted before they show signs of wilting, and the dug plants should not be left exposed until the roots dry out. The plants should be thoroughly watered before and after transplanting, and the beds kept free from weeds and watered as often as necessary.

Clearing and planting.—Wherever possible, the land to be planted in coffee should be stumped, and plowed once or twice, so that after the plants have been set out animal-drawn cultivators can be used to keep down the weeds. Thus the cost of weeding is lessened during the early years of the plantation while the plants are small. If plowing is not feasible holes 1 meter in diameter and at least 30 centimeters deep should be grubbed where the plants are to be set.

On moderately rich land robusta coffee should be planted 2.1 meters apart each way, 2,265 plants to the hectare; on very fertile land the distance may be increased to 2.5 meters, or 1,600 plants to the hectare.

Arabian coffee should be spaced from 2 to 2.5 meters apart or on poor lands even closer.

When the plants are 4 to 5 months old they should be about 20 centimeters tall and ready for transplanting. About one-half of the foliage should now be cut off; a trench should be dug at the end of the nursery bed about 20 centimeters or more deep; then a thin, sharp spade or bolo (cutlass) should be passed through the soil, underneath and around the plant, neatly severing all straggling roots, and leaving the plant in the center of a ball of earth. The plants should be set out in the field at the same depth at which they grew in the nursery, great care being taken not to break the ball. If the soil is so loose that it falls away from the roots in the removal from the nursery, great care should be exercised in not allowing the roots to dry out and in setting out the plant so that the roots fall in a natural position. In the course of the planting the soil should be firmly packed about the roots.

The sowing of the seed in a given locality should be so timed that the plants are ready for transplanting at the beginning of the rainy season in order to avoid the expense of artificial watering. If transplanted during the dry season the plants necessarily would have to be watered by hand from time to time until they are established.

Plants for shade.—As a temporary shade and cover crop of rapid growth while the coffee trees are small, perhaps no plant can compete with the cadios (*Cajanus indicus*). The plants may be cut down to serve as mulch whenever they grow too high, and may be expected to grow from the stubble twice before the plants die, provided they are not cut off too close to the ground.

In Java, where robusta coffee is more extensively planted than anywhere else, permanent shade is considered advisable. Malaganit (*Leucaena glauca*), a leguminous shrub which grows everywhere in the Philippines, seems to be preferred there to other plants for shade. It is planted alternately with the coffee plants and, as is the case with all plants utilized for shade, thinned out later according to need. Madre de cacao (*Gliricidia maculata*) and dapdap (*Erythrina indica* and *E. subumbrans*) are other leguminous trees readily obtainable in most localities and are adapted for shade.

Madre de cacao should be planted at the same distance as the

malaganit while the dapdap should be planted one plant to every two coffee trees. All these plants are readily propagated by cutting off limbs or branches 1 to 1.2 meters long and inserting them 20 to 30 centimeters deep in the ground during the rainy season. (This is most conveniently done by the aid of a crowbar.) In a limited way fruit trees, such as the soursop, custardapple, breadfruit, and jak may also be used as shade, and these should be planted from 6 to 12 meters apart according to size. The necessary shading between these trees while they are small may be provided by planting malaganit, etc.

Robusta coffee has also been successfully interplanted with coconuts. In this case the palms and coffee should of course be planted at the same time, the palms perhaps not closer than 9 to 10 meters apart, the coffee to be used as a "filler" between the coconuts. In this connection it is perhaps well to state that in Java robusta coffee is very frequently planted as a "catch crop" in the Hevea rubber plantations. Among the shade plants available to the Philippine planter, malaganit, dapdap, and "guango," or raintree (*Pithecolobium saman*), have given the best results in Java for the robusta with the following ratio yield of coffee: 4.75, 4.10, and 3.06.

Cultivation.—On level and well-cleared land, close attention should be paid to keeping the coffee plantation free from weeds during the first year or two by means of animal-drawn shallow cultivators, supplemented with hand-hoeing. Where the topography of the land or the presence of stumps renders this impossible the weeding must of course be done by hand. All weeds should be left in the field where they serve both as a mulch in preserving the moisture and to enrich the soil. As soon as the plants begin to shade the land they thereby aid in the weed eradication, and weeding then becomes less expensive.

Pruning.—If the trees are allowed to grow without pruning they become too tall (robusta coffee attains a height of 6 meters or more), and the topmost berries are then difficult to pick. Furthermore unpruned coffee trees (including robusta), have the peculiar habit of bearing their branches near the ground and at the top, leaving the middle bare or nearly so which decreases the producing capacity of the plant. On this account up-to-date planters have generally adopted a system of pruning by which the coffee trees are headed low, giving a maximum yield coupled with easy access to the berries.

The pruning consists of topping the robusta trees when they are from 2 to 2.5 meters tall and of subsequent pruning to keep

the trees at this height. This work should preferably be done while the plants are of the proper height and the green shoots easily broken off, and not after the trees have exceeded the height limit by several decimeters. The plant, if allowed to do so, usually sends up a large number of suckers from the base, which constitute a drain on the vitality of the plant. Therefore, all superfluous suckers should be removed and not more than 2 to 3 stems to a plant should be permitted to develop.

Occasionally robusta plants appear that are more than ordinarily subject to blight, and these should be at once pulled up and burned.

Yield.—The yield of robusta coffee is quite variable, much depending upon the fertility of the soil. On the more fertile soils in Java the yield per hectare in the third year was approximately 540 kilograms, and in the fourth and fifth years, 1,400 and 1,830 kilograms, respectively. In old coffee or cacao fields the yields were 325, 540 and 850 kilograms per hectare, respectively, during the third, fourth, and fifth years after planting. It is perhaps well to recall the fact that the average yield of Arabian coffee in the Philippines is 174 kilograms per hectare, which is of course much less than it should be, and *it is not believed that the Philippine planter with his present methods of cultivation could equal with robusta coffee the yields quoted from Java.*

The immense superiority of the robusta as a cropper over the ordinary Arabian coffee is best illustrated in a table published by the Department of Agriculture, Java. We learn here that in Java, under identical conditions, the yield per plant was of Arabian coffee, 53 to 97 grams; of robusta, 992 grams; and of quilloi (a new very rare coffee) 1,020 grams. The Maragogipe hybrid on its own roots yielded 14 to 18 grams, while grafted on robusta the yield was 156 grams, a larger crop than any Arabian coffee has given in Java. This would tend to show the possibilities of robusta as a stock. Further, comparative studies by Cramer have shown that 4 to 5 kilograms of fresh robusta berries make 1 kilogram of coffee while of the Arabian coffee 5 to 6 kilograms of fruit are required to make 1 kilogram of coffee.

Owing to the fact that the pulp on the robusta coffee (though smaller in amount) is more difficult to remove than that on the Arabian, robusta needs at least two and one-half days of fermentation. The bean requires rapid drying in order to loosen the silver skin and the drying is therefore done in an artificially heated shed.

Quality and marketability.—Relative to the quality of the robusta coffee Doctor Hall says:

> The appearance of the average marketable robusta is not very beautiful; the beans are small and irregular, and the average product shows little uniformity. There are, however, great differences between the many different types of robusta. Some of them have comparatively large beans, larger even than arabica, others again have very small ones. As regards the quality, though being inferior to Java-arabica, the taste is generally considered to be good and superior to the ordinary arabica sorts, as Santos.

Doctor Wildeman states:

> It is objected that the berries of the robusta group and of other African coffees are small in size and inferior in flavor; but the continually increasing quantities of these coffees sold in Holland, and the satisfactory prices they fetch show that the public is beginning to appreciate them. No objections will be made to the size of the berries when by means of careful cultivation and especially of right preparation, a coffee is obtained equal in flavor to the (old) Java and Arabian coffee.

SUMMARY.

Arabian coffee cannot be successfully grown in the Philippines below an altitude of 800 meters, and even at this elevation, due to its susceptibility to the coffee blight, extensive planting of Arabian coffee cannot be recommended.

Success with Arabian coffee is obtainable only by keeping the plantations clean of weeds and the plants in the best possible condition.

For the rehabilitation of the Philippine coffee industry robusta coffee appears more promising at present than any other kind.

The advantages of robusta coffee are that it thrives under more varied conditions than Arabian coffee, that it is an earlier and a more prolific bearer and that it is resistant to the blight.

Blight resistance in robusta coffee does not mean that it is *immune*, but that *notwithstanding the presence of the blight it grows well and produces abundant crops.*

Robusta coffee is by some authorities regarded as inferior in quality to Arabian coffee. Nevertheless, considering the optimism with which robusta coffee is regarded by conservative European experts in tropical crops, coupled with the results obtained in Java, it is confidently believed that robusta coffee is worthy of extended planting in the Philippines.

From the Dutch department of agriculture in Java the Bureau of Agriculture has imported seed of the best robusta coffee available for distribution, as well as a considerable quantity of seed of the ordinary robusta cultivated in that island. All readers who are interested in planting robusta coffee are cordially invited to communicate with the Bureau of Agriculture.

CANE-JUICE CLARIFICATION.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

The clarification of the juice forms one of the most important operations in sugar manufacture, since the higher the purity of the juice to be concentrated, the greater the percentage of sucrose that will crystallize, and the easier it will be to make a marketable sugar. If a high-grade sugar, or even yellow clarified sugar is to be made, this work should receive still greater attention.

Before considering the methods to pursue and the reagents to use, it is well to decide first upon the grade of sugar it is desirable to make. If ordinary centrifugal sugar testing 96° is desired, it will usually be practical to use only lime in the clarification, since in these Islands cane reaches full maturity, and consequently the purity of the normal juice will be quite high, sometimes as high as 90° or 92° (apparent purity). If, however, it is desired to make a white plantation sugar, or granulated sugar, it will be advisable to subject the juice to an acidifying or bleaching treatment, as well as to the lime treatment. Usualy sulphurous acid is used for this purpose, but sometimes phosphoric acid, or a form of it, is employed. It is generally best to administer the acidifying agent before the application of the lime, since this raises the acidity and permits a larger amount of the lime to be used. However, this process is reversed by some manufacturers, and very good results are often reported.

In the acidifying of any cane juice, care must be exercised that too high an acidity is not reached, since acids have an inverting effect upon sucrose, thus causing a noticeable loss. This of course depends upon the degree of acidity carried, the temperature maintained, and the methods followed during the time the juice remains acid.

When it is desired to make a high-grade crystal for granulated sugar, the clarification must be more complete, and a water-white thick liquor should result, without subsequent treatment by bleaching agents and other chemicals, except the neutralizing of the slightly yellowish tint, which will be mentioned later.

REAGENTS USED IN CLARIFICATION.

There is a great variety of reagents at the command of the sugar manufacturer, each of which has certain merits over others, and all are valuable in their place when properly used. It will therefore be the duty of the operator to select those which best meet his individual conditions.

It is the purpose of this article to give a brief survey of the more common reagents which, under certain conditions, may be used to advantage in these Islands.

Lime.—This is perhaps one of the most common and most widely used of all the reagents. Since the object in view is to increase the purity of the juice, it is obvious that the purest rock obtainable should be used in the preparation of the lime. Another reason why a good lime should be employed, is that one of the main impurities of the lime rock is magnesium, which, when mixed with cane juice, becomes very troublesome in the incrusting of the evaporator tubes, thus greatly lowering the coefficient of heat transmission.

Much of the lime on the market in the Philippines has been made without any attempt to select pure clean limestone or shells. This is not suitable for putting into cane juice, and will result in a great deal of trouble whenever used in modern evaporating plants. There is, however, an abundant supply of limestone found in various parts of the Philippines, which analyses show to be almost free from impurities, and which will make a most excellent lime for clarifying purposes if burned properly. At present there is no modern plant for burning this rock on a large scale and consequently much of the work is done in a very crude and unsatisfactory manner. Most of the lime for clarification, in modern sugar factories, is imported, and constitutes a very heavy expense. If a lime kiln were installed in conjunction with some of our sugar factories, fresh and well-burned lime might be made as needed. The carbon dioxide could be used in the juice clarification, as is done in Java, and thus a good grade of plantation sugar could easily be manufactured. Any excess of burned lime might very readily be sold to other factories, which now use only high-priced imported lime.

The lime used should be of the unslaked type, and should be protected from the air until a short time before using. The process of preparing this consists of heating lime rock to a very high temperature, in a kiln for that purpose, whereby the limestone is broken into two component parts, expressed by the following chemical equation: $CaCO_3$ (limestone) heated to high temperature $\rightarrow CaO$ (calcium oxide) $+$ CO_2 (carbon dioxide).

This calcium oxide, commonly known as "quick lime," is the substance desired in clarification. It should be slaked by being placed in water just before it is desired for use. This milk of lime should not be used until after the high temperature caused by the violent chemical action has subsided. On account of the heat involved and the high alkalinity in local portions, it is never safe to apply crude lime to the juice without previously slaking it in water, nor is it advisable to use a quantity of juice to mix this lime, as is quite often practiced in these Islands, since in this case there may be a loss of sucrose, with a resulting dark-colored product, which will impair the color of the clarified juice. The following chemical equation will express the reaction when this lime is slaked: CaO (calcium oxide) + H_2O (water) $\rightarrow Ca(OH)_2$ (calcium hydroxide).

This calcium hydroxide is a substance which is very caustic, and care must be exercised in handling it. Like all bases, it has a great affinity for acid, and consequently its first action is to neutralize part of the acids present. It then coagulates albumins and albuminoids, which form a part of the impurities, and throws down insoluble salts of sulphates, carbonates and phosphates, and of the bases iron and aluminum. These act as mechanical precipitants, assisting in bringing down other impurities. The compounds of calcium are practically insoluble in cold cane juices, and may be readily filtered, or settled, and the supernatant liquor drawn off. In the addition of lime, as well as in the application of other reagents, much care must be observed that the proper amount is added. If too little is used, there will be poor clarification and settling of the precipitate, while if too much is used, so that alkalinity is reached, and the juice heated to a high temperature, there will be a darkening of the juice caused by the decomposition of the reducing sugars by the calcium, and the formation of dark-colored compounds, which are very hard to remove. If the juice is limed to three-tenths or four-tenths cubic centimeter acidity against N/10 NaOH, using phenolphthalum as an indicator, there will be little or no chance of trouble. With the above dangers in view, it is not safe to employ the haphazard methods of liming usually practiced here, but the milk of lime should always be made of stated density and a measured or weighed amount should be supplied to each clarifier of juice, corresponding to prevailing conditions.

Sulphur dioxide.—Where a better grade of sugar than 96° test is desired, it is often advisable to subject the juice to further treatment, one reason for which is to increase the acidity so that a larger amount of lime may be added to effect the clari-

fication. In addition to this the sulphur acts to some extent directly as a clarifying agent, by precipitating some of the impurities. It also acts as a bleaching agent by extracting the oxygen from the impurities and lastly it acts as a disinfectant. It is formed by burning crude sulphur in a stove made for that purpose. S (sulphur) + O (oxygen heat) $\rightarrow SO_2$ (sulphur dioxide).

Sometimes bombs filled with liquid sulphur dioxide are purchased for this purpose. These are inconvenient to use, and this method is ordinarily more expensive than the usual one of burning the sulphur and producing the gas directly at the factory.

Sulphur dioxide is a heavy gas which is very readily absorbed in water, and at a temperature of zero C. nearly 80 per cent by volume of the gas will be taken up.

At 40° C. only about 18 per cent by volume of the gas will be absorbed. It may readily be seen that the percentage of gas contained in the juice when saturated will be determined by the temperature.

The following equation expresses the absortion of sulphur dioxide in water at ordinary temperature:

SO_2 (sulphur dioxide) + H_2O (water at low temperature) $\rightarrow H_2SO_3$ (sulphurous acid).

Another thing of very great importance is the cooling of the gases to condense any water that may be present so that no hot gas will reach the juice to be treated or combine with water in the pipes. The equation represented when high temperatures are used is as follows:

SO_2 (sulphur dioxide) + H_2O (water) + O (high temperature) $\rightarrow H_2SO_4$ (sulphuric acid).

This last-named acid is very corrosive and a powerful investing agent. It therefore has the property of rapidly destroying sucrose, especially at a high temperature.

In the burning of sulphur it is well that as thorough a combination as possible be obtained, else there will be a loss of sulphur, which will deposit in the tubes and choke them, and more time will be required for the process. The fumes from a well-regulated sulphur furnace should contain from 15 to 16 per cent sulphurous acid. The theoretical percentage obtainable is about 21 per cent of the acid.

Carbon dioxide.—In recent years carbon dioxide gas has found a very useful application in the cane-sugar factories, where a good grade of plantation sugar is desired.

Java factories have been the foremost in elaborating a system, through their eminent technologists, so that today one may find the bulk of the sugars they turn out from certain factories

of a very satisfactory grade and color. The method they use requires a great deal of skill and attention in order to yield results that are satisfactory. It is patterned after the process used in beet-sugar factories, with some distinct modifications, which make it applicable to a juice containing glucose, as is always the case with cane juices.

The object of applying any clarifying material is to effect a rise in purity, and it is especially desirable to remove, in all cases, the substance added, since this itself would tend to act as an impurity and thus give a lower coefficient, if not properly removed. The lime, which has been added previously, may be partly removed, as the original precipitate formed, and any free lime or compound which may be easily decomposed will combine with carbon dioxide, forming calcium carbonate or limestone, which is quite insoluble and may be very easily filtered off.

$Ca(OH)^2$ (calcium hydroxide) $+ CO_2 \rightarrow CaCO_3$ (calcium carbonate) $+ H_2O$ (water).

Whether single or double carbonation is used, the same general methods are employed, and results are expressed by the same chemical equation.

As stated before, the carbon dioxide may be recovered from the kilns during the burning of lime, as is commonly done in the beet-sugar industry, or it may be purchased in the form of liquid CO_2 contained in heavy iron containers. It is also feasible to use flue gases for this purpose, where a good combustion is obtained, and after they have been properly treated.

Phosphoric acid.—It is sometimes advisable to apply a form of phosphoric acid as a clarifying and precipitating agent after the lime. This may be used in various forms depending upon the individual desires of the operator.

The compound usually found on the market may consist of one of the following (or a combination of them):

H_3PO_4 (ortho phosphoric acid).

$CaH_4(PO_4)^2$ (mono-calcium phosphate).

$Ca_2H_2(PO_4)^2$ dicalcium phosphate).

Na_2HPO_4 (sodium phosphate).

The sodium phosphate contains very little acidity, and the main purpose of its use is based on the principle that the sodium is readily given up for any soluble calcium that may be present. This forms the insoluble calcium phosphate, which is easily removed as a precipitate or filtered off. The "Reserve Factory" in Louisiana has been using this reagent in their clarification for a long time, where a very good grade of granulated sugar is made.

Besides these forms of phosphorous, various compounds may

be found on the market, under trade names, which have as their base the above acid. "Clariphos" is one of these compounds, which has found extensive use in many of the Louisiana sugar factories.

Another is known as "phospho-gelose," which is a combination of dicalcium phosphate $Ca_2H_2(PO_4)_2$ and infusorial silica. It is a patented preparation and is made by the absorption of phosphoric acid by a powdery compound known as "Kieselguhr." After the absorption, the compound is heated to expel the water, and then resaturated. This work is repeated several times until the finished product, which is very hydroscopic, contains about 25 per cent of phosphoric acid.

Kieselguhr.—This is a fine light powder containing a high percentage of silica. It is used purely for its mechanical effect in forming particles upon which the impurities may collect, and thus be more readily carried to the bottom. This material often prolongs the workings of the filter presses by collecting the gummy material, which would otherwise gather on the filter cloths. Kieselguhr was used in the beet-sugar industry of Europe many years ago, and is extensively used now for the same purpose in the United States.

Hydrosulphites—These are preparations of great bleaching power, found on the market under various trade names. One of these, widely used in the United States, in both the beet and cane-sugar industries, is known as "Blankit." This is dehydrated sodium hydrosulphite with the chemical formula, $Na_2S_2O_4$. It has a much greater bleaching and reducing action than sulphurous acid, and oxydizes very readily in combination with moisture, forming sulphate. On this account it is well to purchase the reagent in small parcels for this climate, and to carefully guard the stored material from moisture. This substance, which is a white powder, dissolves very easily in water, forming an alkaline liquid, although this point is sometimes hard to distinguish on account of hydrogen atoms liberated.

There is a bleaching preparation made in France known as "Redo," which is simply calcium hydrosulphite (CaS_2O_4). This is used in the sugar industry to some extent, but it is claimed by many that the results obtained are not as good as those obtained from the sodium compound and that it deteriorates more easily.

Hydrosulphites, unlike sulphurous acid, will bleach equally as well in alkaline or neutral medium, as in an acid medium. There is therefore less danger from loss of sugar by inversion when they are used, while the permanency of their effect is about the same. In any case where juices have been bleached

by sulphites, the result may be considered as but temporary, since upon exposure to air and light the product assumes a darker color. Hydrosulphites should therefore be introduced as late in the process as possible. Where the material in the vacuum pan is to be bleached, it is well to introduce this reagent just before striking grain, thus furnishing a bright clear material which will act as film over the nucleous of sucrose in the grain.

The chemical equation representing the change which takes place with this reagent is as follows:

$Na_2\ S_2O_4$ (sodium hydrosulphite) $+O$ (oxygen) $+H_2O$ (water) $\rightarrow 2(Na\ H\ S\ O_3)$.

The amount to be used will depend absolutely upon individual conditions, which may be ascertained only by experimentation. The manufacturers of this product state that the amount of the material used to that of dry sugar should be as 1 is to 10,000. In the writer's experience, two or even three times this amount will usually be required to give maximum results. As stated before, since there is such a variance in the material to be treated, each operator will be required to judge this to a great extent from the condition of his product.

In these Islands where a very low grade of open-kettle sugar is still made, which sells very cheaply, attempts are often made to bleach it and recrystalize in order to make a centrifugal sugar.

While ordinary clarifying agents help to a great extent, if the melted sugars are very dark from caramel and the decomposition products of calcium glucosate, these reagents can not be expected to give a light-colored juice. While they may improve conditions somewhat, the only solution to such a problem is the use of the boneblack process.

Bluing.—In the production of plantation clarified sugars, and sometimes of refinery crystals made from low-grade sugars, there is a thin film surrounding each sugar crystal, which has a yellowish tint. It is this that gives rise to the different grades of white sugars, when color test only is considered. Since this yellowish tinge will give way to a lighter color when neutralized with the proper shade of blue, it is a very common practice to use some form of bluing—usually that known as ultramarine—for this purpose.

The action of this reagent is only mechanical and great care must be exercised that the proper quantity is used. This must be determined by trials with the different amounts of the reagent, since the density of the yellowish tint is different in each case.

The place of application will also depend very much upon con-

ditions. Some operators apply it only at the centrifugals and others apply it in the pan just at the graining point. Again others use a quantity at both the pan and in the last charge of water at the centrifugals. In any case, a good grade only of the reagent should be used. This must be thoroughly dissolved in clear water, condensed steam being preferred, and passed through cloth or felt filters in order to remove any trace of lumps which would tend to produce uneven bluing, or bluish streaks.

While this is an excellent reagent in its place, it must not be expected to whiten molasses sugars as was attempted by a local manufacturer.

Animal charcoal or boneblack.—This material is made from bones of animals, by burning them in a kiln built for that purpose. The object of this burning is to remove the organic matter and leave the remainder in a porous condition, so that it may be crushed into particles the proper size. It is not desirable to have a great amount of char dust present, since this retards the passage of the liquors through the filters, as well as impairing the efficiency of the work.

Bone char, being very porous, absorbs a great volume of gases, among which is oxygen, and it is ordinarily presumed that its bleaching power may be attributed to this fact. Extensive experiments have been made to determine definitely this point, and the char has been subjected to an atmosphere of other gases than oxygen. This proved that the char still contained great clarifying power.

Char also has a great surface attraction, which causes it to collect particles of coloring matter that may be present, and thus acts as an excellent filtering agent. New char should be thoroughly washed with pure water until all the impurities are removed. With the end in view of determining when the last traces of chlorine have disappeared, chemical tests are made on the wash waters. Nitric acid and silver nitrate are employed for this purpose. After animal char has been used for some time in the filters and fails to do its work efficiently, it is reburned, or revived, as it is called. Ordinarily the best results are obtained after a char has been used several times.

Reburning of the char at too high a temperature should be avoided, as it incurs an unnecessary loss of fuel, besides causing serious injury to the char by a contraction of the pores. Since, as stated previously, the main value of the char as a clarifying and filtering medium lies in the fact of its porosity, anything which reduces this will greatly impair its efficiency. One thing in connection with the bone-char process of making white sugars

is that it is expensive and should not be attempted except on a large scale, since the initial expense of installation, as well as the cost of running, is very great. The writer is sometimes asked by managers of small factories, turning out plantation yellow clarified sugars, if it would not pay them to employ bone-char filters to use in connection with the remainder of their factory, in order to be able to work up an industry with the low-grade open-kettle sugars, during the intercampaign. Most assuredly such a combination of small plantation factory and refinery would not be a paying affair. It takes men of experience and special training to carry out successfully the more detailed work in any technical line. One thing, however, can be very successfully done by these factories, and that is to make a first-class plantation white sugar which will command a ready price in the local markets, or even suffice for export, if the proper manufacturing methods are used.

It is not presumed that any one planter will use all of the clarifying reagents mentioned above, but he should choose the ones to fit his individual needs, and secure his supply early, since a great deal of time is required to transport supplies from the place of manufacture to these Islands. This is especially the case when the place of manufacture happens to be in Europe, as is true with a number of the patented clarifying reagents.

Then, again, a suitable place should be selected for the storage of reagents, where they may be protected from dampness. The quick-lime and sulphites are especially susceptible to moisture, while the greatest danger of loss, when phosphoric acid compounds are stored, will result from leakage. This is on account of the great oxydizing effect of the acid on the iron loops surrounding the barrels, whereby a great quantity may be lost within a very short time. The writer observed this needless waste in one of the small factories here, when twenty barrels of a high-priced acid were stored on the damp ground of the factory, and a great percentage of it wasted.

There are a number of clarifying agents offered on the market under fancy names. Planters are advised to be cautious about the purchasing of such supplies until they have been thoroughly tried out and proven a success. Even then, it is better to experiment only on a small scale until it is known that they will meet their individual needs.

Some of these are not only deficient in clarifying power, but actually act as an absolute detriment by introducing impurities which lower the value of the juice as well as increasing the subsequent work of boiling and after working of the sugar.

LA FABRICACION DE AZUCAR BLANCO EN LOS INGENIOS.

By W. H. TH. HARLOFF and H. SCHMIDT.
Translated into Spanish by C. J. BOURBAKIS.
(Reviewed by CLEVE. W. HINES, M. S., *Station Superintendent.*)

This book is edited by two of the foremost sugar producers of the world, Mr. Harloff, who is manager of a large sugar factory in Java, and Mr. Schmidt, a very able consulting chemist and engineer.

The book was originally written in Dutch and was translated into English, and now the Spanish edition has been completed, which will be welcomed by Spanish readers throughout the sugar world.

While dealing with a purely technical subject, this work is so simple in its diction that it may be readily comprehended even by those of little technical training.

The introduction is divided into five parts as follows:

Part I.—The influence of alkalies and alkaline earths on the constituents of cane juice.

Mention is here made of the formation of saccharates of barium, strontium, and calcium in low concentrations. The latter is made use of in the famous Steffens process of the beet-sugar industry.

Part II.—The influence of acids on the constituents of sugar cane and the hydrolizing effect of dilute acids on sucrose and the resulting constituents, laevulose and dextrose or invert sugar, are explained.

Part III.—The influence of heating on the constituents of cane juice is shown.

Part IV.—The coloring substances of cane and those produced in the process of manufacture.

Part V.—The different fermentations that occur in the sugar factory including lactic, butyric, alcoholic and dextran are discussed.

The main part of the text deals with the manufacture of white sugar by the carbonitation and sulphitation processes, and particular attention is given to the acid-thin-juice-method which has been elaborated in the Java factories with such great success during the past few years.

This book may be obtained from Norman Roger, 2 St. Dunstan's Hill, London, England. Price 7s. 6d. net (₱4 Philippine currency).

CURRENT NOTES—FIRST QUARTER.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao Experiment Station.

SHIELD BUDDING THE MANGO.

The one defect in the Pound method of shield budding the mango described in Bureau of Agriculture Bulletin No. 18, The Mango, consists of the necessity of placing an apron to protect the long petiole left on the bud from the sun and the entrance of water, which work necessarily requires more time than if the bud could be wrapped as is the case in budding citrus trees. However, a possible use of scarred or nonpetioled budwood as a means of obviating the need of the apron was suggested in the above-mentioned publication. The results obtained in recent experiments conducted at the Lamao experiment station (November and December, 1914) have fully come up to the expectations of this modification, and if the work is carefully performed, the operator should have no trouble in obtaining 85 per cent of live buds by proceeding in accordance with the following directions:

(1) Select budwood that is well matured, from the first, second, and third flushes from the end of a branch. This budwood is always green and smooth.

(2) Three weeks or more in advance of the date when the budding is to be performed, cut off the leaf blades of the budwood selected. This causes the petioles to drop. When the scars left after the petioles have fallen are well healed the budwood is in condition for budding.

(3) The buds should be cut about 4 centimeters long, with an ample wood shield, and inserted in the stock at a point where the bark is green and smooth like the budwood, not where it is rough and brownish.

(4) Use waxed tape in tying and cover the entire bud.

(5) When in the course of two to three weeks a good union has formed, unwind the wrapping so as to expose the leaf bud from which the growth is to issue, and cut off the top of the stock 10 to 15 centimeters above the bud.

(6) Every ten days after unwrapping the buds go through the nursery and carefully rub off all stock sprouts in order to force the buds to grow.

All other precautions that are taken in ordinary shield budding must, of course, also be attended to in order to insure success.

EXPERIMENTS IN SHIELD BUDDING.

After repeated attempts the shield-budding experiments at the Lamao experiment station with the camia (*Averrhoa Bilimbi*) and the santol (*Sandoricum koetjape*) have been successful, and it has also been found that the barobo (*Diplodiscus paniculatus*), a nut tree indigenous to the Philippines (*Dillenia indica*), and the sea grape (*Coccoloba uvifera*), may be propagated by means of shield budding. Detailed information relative to the budding of these plants will be published on the completion of the experiments.

IMPROVEMENT OF TROPICAL FRUITS IN THE PHILIPPINES.

The average fruit is so poor that most foreigners never give any attention to the santol, and the fruit is a drug even in the native markets and enormous quantities annually rot on the ground. Few are aware that there are mutations among the santol trees the fruit of which in point of flavor vies with the best fruits in the Tropics, and that in this respect it is superior even to its celebrated relative, the lanzon (*Lansium domesticum*), the greatest defects being the large seeds and the adherence of the flesh to the seeds. If the seed in these superior santols were abortive in the same proportion as those in the mangosteen, the now despised santol, with its translucent pulp, separable from the pericarp as that of the mangosteen, subacid, juicy and of a vinous, excellent flavor, would rapidly become one of the most popular fruits in the Tropics. Its thick, tough "rind" should make the santol at least equal to the mangosteen as a shipper.

What is probably the first horticultural, asexually propagated variety of the santol is now being established at the Lamao experiment station from buds obtained by Mr. F. Galang, assistant agricultural inspector, from a tree in Pampanga, the fruit of which is so highly prized locally that the fruit never retails below the relatively high price of 2 centavos apiece even when other santols are so plentiful as to be literally unsalable.

Mr. B. Malvar, assistant agricultural inspector, has obtained in Batangas budwood of a sweet-fruited camia which is also being propagated. This is the first mutation of this kind coming to the attention of the writer.

The collection of Philippine citrus fruits of economic value or of botanical interest has been in progress since in 1911, but no systematized selection work in the mandarin district has been attempted until December, 1914, when Mr. B. Malvar was detailed to visit the citrus region in Batangas. Mr. Malvar re-

turned with sample fruits of some twenty odd trees, a number of which were found to be of very good quality. These are being propagated for future distribution. Mr. Malvar also found another "Tizon" (*Citrus nobilis* var. *papillaris*) of excellent flavor and quality which has been added to the citrus collection at Lamao.

PETIOLED VS. NONPETIOLED BUDWOOD.

The last three years' experiments in shield budding tropical fruits which have been conducted by the writer at the Lamao experiment station indicate that for practical purposes in propagation work the tropical fruits may be divided into two groups: (1) Those species the budwood of which may be cut at the time of budding and the petioles cut off close to the bud—for instance, the citrus fruits, avocado, guava, and carambola; and (2) those species in which decay enters the bud from the adhering remnant of the petiole so frequently as to make impracticable budding from newly cut budwood from twigs with the leaves still adhering, such as the mango, hevi, and cacao. It has been found, however, that this trouble may be easily overcome by the simple method of cutting off the leaf blade about three weeks in advance of when the budding is to be done so as to induce the formation of a leaf scar. Then when the petioles have dropped and a well-healed scar has formed, the budwood may be cut and the buds inserted and tied as in ordinary shield budding.

In the case of some species, whether or not the bud is of the same age as the stock at the point of insertion is of little or no practical importance, but in other species this condition is one of the requirements for success. Therefore, two chances of failure are insured against in experimental work with species that hitherto have not been budded—(*a*) by defoliating the budwood previously to the budding operation, and using what may be termed nonpetioled or scarred budwood; and (*b*) by inserting the buds at a point in the stock which approximately is of the same age and appearance as the budwood.

NOTES BY CLEVE. W. HINES, M. S., *Station Superintendent.*

A NEW SUGAR INDUSTRY.

The beginning of a tropical industry in what would be considered a semitropical climate was noted in 1914, when the Southwestern Sugar Company of Arizona milled their first crop of sugar cane and made it into sugar. The factory had been used previously for the manufacture of beet sugar only. It is a

singular coincidence to find a region where both cane and beets will thrive well and where sugar is made from both sources in the same factory, and the sugar world is looking forward with great interest to the results of this new venture.

THE WORLD'S SUGAR SUPPLY.

The world's production of sugar amounts to nearly seventeen million tons, practically one half of which is derived from the beet root, the greater percentage of which is produced in Europe. Now that the ravages of war have devastated many of the better beet-sugar regions of Europe a greater demand will be made on the more fortunate sugar countries as soon as the present supply of storage sugar is exhausted and trade resumes its normal condition.

PROGRESS IN SUGAR MANUFACTURE.

The past few years have shown great progress in the method of sugar making. It used to be thought that a high grade of sugar could be made only by the use of the bone-black or animal-char process.

The beet-sugar producers were the first to diverge from this method and succeeded in making a perfectly satisfactory sugar in their factories in one continuous process by the aid of the carbonitation system.

Louisiana had been making a fairly good sugar known as yellow clarified for a number of years, but the great step in improvements along these lines was brought about by the acid-thin-juice process of Java. This was a combination of the carbonitation and sulphitation processes which gave a satisfactory sugar, though unfortunately the yield of resulting molasses was also quite high.

The latest improvement in this work was the introduction of the "Battille Process" which has certain similarities to the Steffens process of beet-sugar manufacture. This method has given an excellent grade of sugar and the maximum rendement since practically all of the sugar is extracted in crystalized form.

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The Philippine Agricultural Review

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SPECIAL ARTICLES

THE LAMAO EXPERIMENT STATION

By P. J. Wester

CLINICAL OBSERVATIONS ON COCCIDIOSIS IN CATTLE AND CARABAOS

By C. H. Schultz

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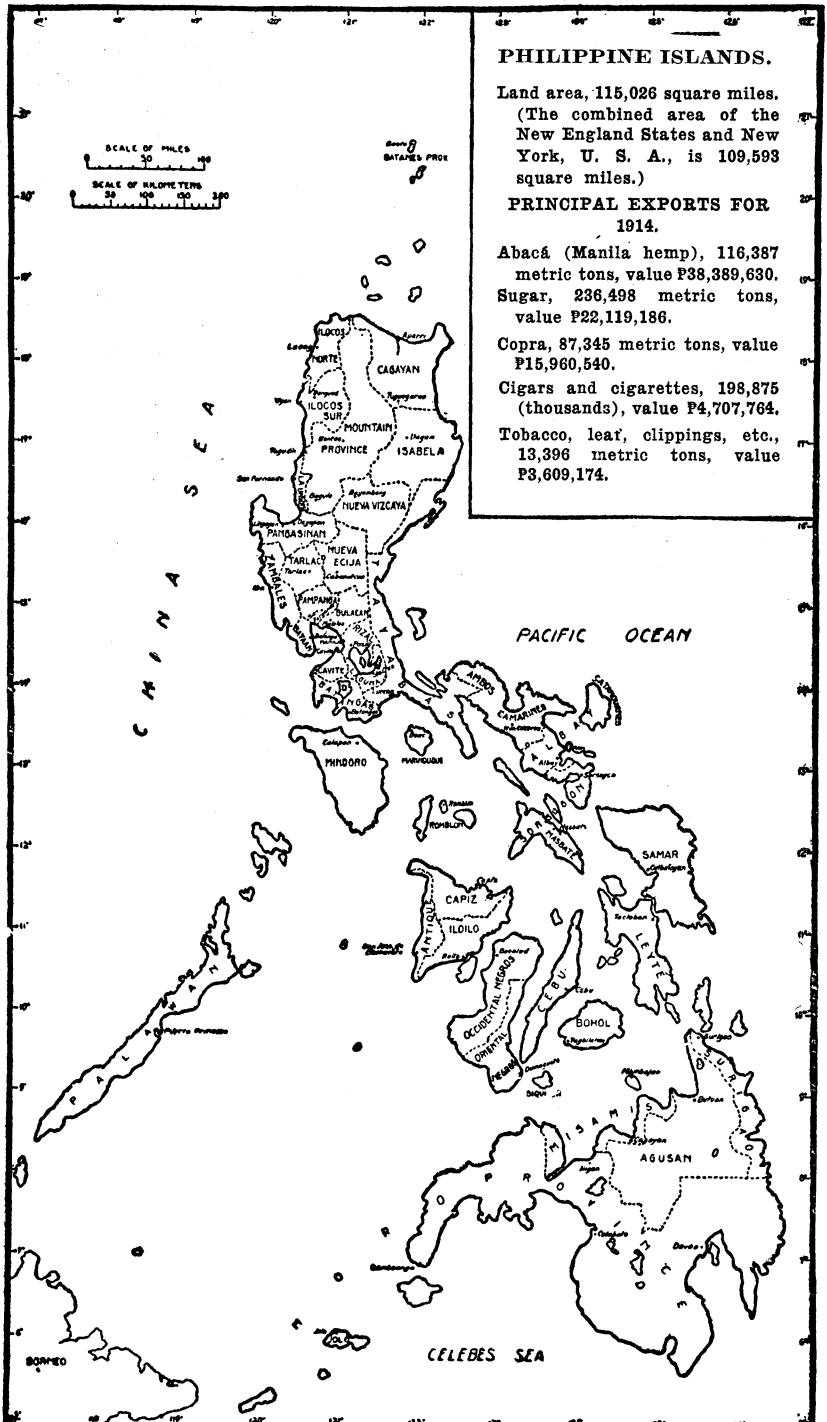
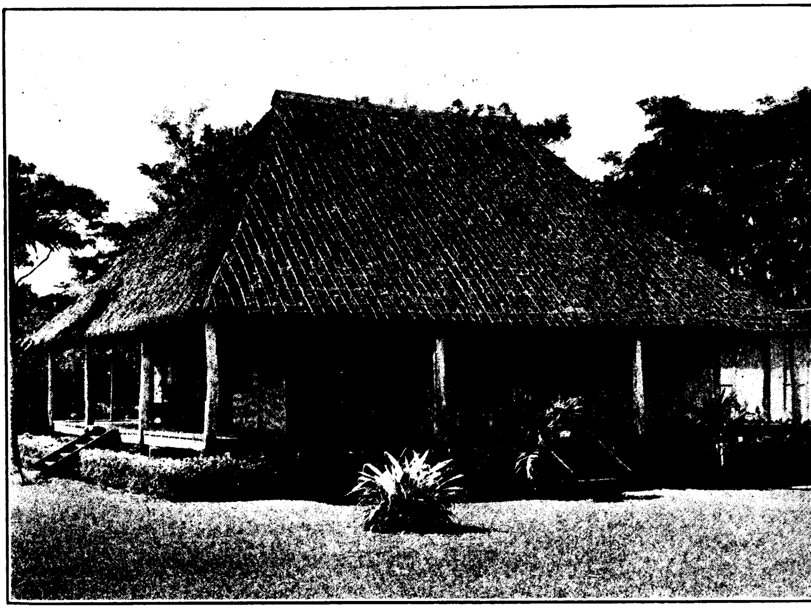

PHILIPPINE ISLANDS.
Land area, 115,026 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1914.
Abacá (Manila hemp), 116,387 metric tons, value ₱38,389,630.
Sugar, 236,498 metric tons, value ₱22,119,186.
Copra, 87,345 metric tons, value ₱15,960,540.
Cigars and cigarettes, 198,875 (thousands), value ₱4,707,764.
Tobacco, leaf, clippings, etc., 13,396 metric tons, value ₱3,609,174.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
CHINA SEA
PACIFIC OCEAN
CELEBES SEA
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
TARLAC
NUEVA ECIJA
ZAMBALES
PAMPANGA
BULACAN
BATAAN
RIZAL
CAVITE
TAYABAS
AMBOS CAMARINES
ALBAY
SORSOGON
MINDORO
MARINDUQUE
ROMBLON
MASBATE
SAMAR
CAPIZ
ANTIQUE
ILOILO
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
LEYTE
SIQUIJOR
PALAWAN
MISAMIS
SURIGAO
AGUSAN
MORO PROVINCE
BORNEO



(*a*) Office building, Lamao Experiment Station, 1914.

(*b*) Residence of superintendent, Lamao Experiment Station, 1914.

THE PHILIPPINE

Agricultural Review

VOL. VIII SECOND QUARTER, 1915 No. 2

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THE FARMER'S PROFESSIONAL STATUS.

Agriculture was one of the first professions which man adopted in his evolution from primitive or elemental conditions to those more modern or complex.

As he began to cultivate the soil, to plant seeds and to harvest crops, he met problems to be solved, and, groping about for a solution of these, he quite by accident discovered that certain causes produced given effects.

Thus, we note that for ages the agriculturist has practiced plowing the soil, though unable to give good reasons for so doing. Even to this day, in the older communities, one hears a certain practice defended on the score that it is customary; it is, in other words, sanctified by virtue of tradition.

When the attempt was made to cause the farmer or agriculturist to introduce science in his work, the struggle was quite severe.

On one hand was the farmer's aversion to change, his sense of independence being touched, and it was his opinion that the public and the government should mind their own business. On the other hand, the public upbraided the government for not doing more for the farmer and often insisted that its officials and institutions should place themselves on the same intellectual level as the farmer.

Science is knowledge of principles or facts, or, in other words, systematized knowledge.

How can an institution which owes its existence to systematized knowledge place itself on the basis of conjecture, superstition and tradition?

Some of us can recall hearing many scathing criticisms of "book farming" methods, and sarcastic remarks directed at the state agricultural institutions and the federal department of agriculture.

Twenty-five years ago agriculture as a scientific profession had but little systematized knowledge as a basis and farming then was carried on along lines largely traditional.

During the last twenty-five years tremendous advances have been made in agricultural science; in fact, the advance has been so rapid that the layman does not realize the changes which have occurred. Meanwhile, a metamorphosis of the agriculturist has taken place. He has seen the advantage of better general education, has availed himself of his opportunities and has secured better facilities for the education of his children. With this gain in general education has come appreciation of specialized training, which has resulted in the establishment of agricultural schools. The spirit of progress has made him a student and a reader, and, to gratify this desire for up-to-date information relating to his profession, several thousand agricultural publications have sprung into existence.

The agricultural scientist has not descended to the farmer's level but the farmer has ascended towards the scientist's level.

Today the world realizes, at least in a measure, that agriculture is a scientific profession; then, should it not also grant the presumption that those who follow this profession are capable of comprehending its language?

In discussing the farmer it would be well for the public at large to educate itself to a better comprehension of his dignity and economic importance, and to appreciate the marked advancement he has already made.

THE LAMAO EXPERIMENT STATION.[1]

By P. J. WESTER, *Horticulturist in Charge.*

The Lamao forest reserve, containing about 4,426 hectares, located 7.5 kilometers south of Limay, Province of Bataan, was established by proclamation of the Governor-General July 26, 1904. The present experiment station, situated on the reserve and having a fenced area of approximately 40 hectares, of which about 15 to 18 are under cultivation, is exceptionally well located both from an esthetic and a practical point of view, its chief drawback being isolation from any trade route.

Owing to the peculiar formation of the land, the station enjoys many natural advantages that are seldom combined. Its location is unusually attractive, the experimental fields being well sheltered by forested hills and individually separated by small creeks along which grow luxuriant bamboo, forming admirable natural windbreaks. During the rainy season the creeks carry off the surface water and during the dry season they absorb the surplus water in the course of irrigation. The gentle slope of the fields from west to east facilitates irrigation, for which a superabundance of water is obtained at a slight expense from an arm of the Lamao River which skirts the station on the south.

The soil is a clayey loam of average fertility with varying admixture of sand. Practically all the land must be carefully watched relative to cultivation after irrigation, for if plowing or cultivation is performed either when the soil is too wet or too dry, it breaks up into large, hard clods. With the continued plowing-under of green-manure crops this defect will disappear in time.

No records are now available of the precipitation at Lamao previous to 1913. The total rainfall during 1914 was 3,207 millimeters, falling principally from June to October, thus necessitating irrigation during the larger part of the year. While there is some variance in the precipitation, this may be considered as typical.

[1] For an earlier account of the Lamao Experiment Station see this REVIEW, Vol. III (1910), No. 10, page 581.

The site of the Lamao Experiment Station was selected by Major Geo. P. Ahern, recent Director of Forestry, and ground was first broken in August, 1903. The Bureau of Forestry established three stations: station No. 1, which is the present experiment station, fronting on Manila Bay; station No. 2, approximately 4 kilometers from the bay at an elevation of 60 meters; and station No. 3, about 17 kilometers inland and 600 meters above sea-level.

November 10, 1905, the Lamao station was transferred from the Bureau of Forestry to the Bureau of Agriculture and Mr. Harold Cuzner was appointed superintendent. Mr. Cuzner was succeeded in January, 1908, by Mr. H. E. Stevens who continued in charge until February, 1909; he was followed by Mr. O. B. Burrell who remained at Lamao until March, 1912. Mr. F. C. Kingman then superintended the station until December, 1912, when the writer was placed in charge.

At present the station staff includes the horticulturist in charge, the superintendent—Mr. H. C. McNamara, three agricultural inspectors—Mr. Mariano Manas y Cruz, Mr. Francisco Galang and Mr. Bernabe Malvar, one farm foreman, and one plant propagator. From 8 to 25 day-laborers are employed according to need.

When the station was under the control of the Bureau of Forestry it was operated as a forest nursery and for the propagation of numerous economic and decorative plants which were grown or imported by the Bureau. Some of the more prominent importations made by the Bureau of Forestry included avocados and bananas from Hawaii, papayas from India and pineapples from Ceylon. Deciduous fruit trees were also imported, as well as California oranges and lemons, and 500 coffee trees of various varieties from Java and India. These plants were all planted at the 2nd and 3rd stations. Later, in 1906, when these two stations were abandoned, the living plant material was transferred to the site of the present experiment station.

Having been principally a forest nursery while under the Bureau of Forestry, the station after its transfer to the Bureau of Agriculture up to 1912 was chiefly devoted to horticultural work, the remaining areas being planted to fiber, forage plants and rice. Up to 1911 much time was necessarily occupied in clearing and stumping the land.

Briefly mentioned, the principal plant work up to 1913 was as follows: 4 hectares were planted to sisal and Philippine maguey in 1906; in 1907 there were planted about 200 liberian coffee plants, 48 varieties of grapes, 1.5 hectares of abaca, 1

hectare of bananas including 6 varieties, a small test orchard of guavas and the following tropical fruits: chico, *Achras sapota;* pitanga, *Eugenia uniflora;* genipap, *Genipa americana;* custard-apple, *Annona reticulata;* jak, *Artocarpus integrifolia; Flacourtia cataphracta;* macadamia, *Macadamia ternifolia;* loquat, *Eriobotrya japonica;* kayam, *Inocarpus edulis;* caymito, *Chrysophyllum cainito;* and bael, *Aegle marmelos.* In 1908 there were set out a number of Queen pineapples, an avocado orchard and 0.5 hectare of mulberries. In 1909, 0.25 hectare was planted to kapok and 0.25 hectare to abaca, and also about 50 achuete, *Bixa orellana,* some 300 papayas, 200 robusta coffee plants and a few cacao plants were set out. In 1910 the following tropical fruits were planted: yambo, *Eugenia jambos;* duhat, *E. jambolana;* soursop, *Annona muricata;* breadfruit, *Artocarpus communis* (seedy variety); carambola, *Averrhoa carambola;* mabolo, *Diospyros discolor* (2 varieties); zapote negro, *D. ebenaster;* pulasan, *Euphoria mutabile;* rambutan, *Nephelium lappaceum;* santol, *Sandoricum koetjape;* date, *Phoenix dactylifera;* pomegranate, *Punica granatum;* barobo, *Diplodiscus paniculatus;* tamarind, *Tamarindus* indica; and the following citrus fruits imported from Australia: Oranges—Washington Navel, Navelencia, Bahia, and Mediterranean; Lemons—Belair, Lisbon and Villafranca; also some 500 orange and cabuyao stocks were propagated.

Of the above-mentioned plants both plantings of abacá died because of uncongeniality of climate; all the plants of the tropical and citrus fruits enumerated were in good condition when the writer first saw the station in March, 1911, and are still growing. The growth of both species of coffee was satisfactory and up to date none of the plants has been attacked by blight (*Hemileia vastatrix*). The avocado orchard still remains, though many trees have succumbed to attacks of borers. After testing the fruit of the individual seedlings, about 80 per cent of the guava plants were destroyed by the writer in 1913, leaving the best trees for further testing and breeding work. The cacao died while the plants were small, owing to uncongenial climatic conditions. Most of the bananas were destroyed in 1912 because of the appearance of budrot and a few plants were transferred to another field. The maguey plants and mulberries did very well and yielded very large amounts of plant material for distribution. The kapok and achuete, *Bixa orellana,* plantings were uprooted in 1912 as of no further value. The grapes all died without making any growth worth mention. Rubber plants and various other tropical economics were planted from time to time,

of which the only one of value to survive is the Panama hat palm, *Carludovica palmata.* Large quantities of Lyon beans and okra seed and some robusta and liberian coffee seed were grown for distribution in 1910.

During 1911, 360 varieties of upland rice, 20 varieties of Philippine corn, a large assortment of native vegetables and a large number of imported forage plants were tested. During the same year a stallion, several burros, hogs, goats and sheep were received from Manila for breeding purposes.

When, with the appointment of Mr. F. C. Kingman as superintendent, in March, 1912, the writer was charged with the general direction of the station activities, the Lamao experiment station, barring its isolated location, seemed to be the most desirable point available at which to centralize the horticultural work of the Bureau. In July of the same year the writer formulated a plan for the centralization and conduct of the experimental horticultural work at Lamao, including the abolishment of the animal husbandry work and the transfer to other stations of all live stock at Lamao not necessary for the conduct of the work, the grading and replotting of the station fields, the establishment of a collection of tropical and citrus fruits, and practical training in horticulture of employees of the Demonstration and Extension Division before their detail to horticultural districts of the Archipelago. The work was later segregated into 15 separate projects. This plan was approved by the then Director of the Bureau, Mr. F. W. Taylor, and the then chief of the division of horticulture, Mr. O. W. Barrett.

The reorganization plan was carried into execution at once, and before the end of the year the leveling of the fields and the construction of new roads and irrigation ditches were well under way. Since then the rearrangement of the station has steadily progressed until, in the fields now under cultivation, it is nearly completed. This work has involved more or less leveling of all the fields in order to facilitate irrigation, the completion of a woven-wire fence 2920 meters around the station, the laying of 192 meters of cement drains, the construction of 2.83 kilometers of roads, 17 culverts, and irrigation ditches measuring 2,135 meters in mains and 4,034 meters in laterals, with 25 wooden flood gates. In most instances the irrigation ditches parallel the roads or edges of the fields and during the rainy season serve as drains. Royal palms, *Roystonea regia,* date palms, *Phoenix dactylifera,* Washington palms, *Washingtonia robusta,* and Canary Island date, *Phoenix canariensis,* have been planted out along the roads.

The grounds surrounding the office and the residence of the superintendent (Plate I, frontispiece) have also been drained and remodelled and a new road (Plate IV, *a*) including seven bridges of bamboo has been made from the office through the nipa swamp leading to the experimental fields. A propagation shed of bamboo (Plate II, *b*) covering 1,100 sq. meters was built in 1914; this has now been enlarged to 1,500 sq. meters.

During its session of 1912–13 the Philippine Legislature made a special appropriation for the construction of a plant-propagation shed and store house (58 by 7 meters) (Plate II, *a*), an animal shed, an irrigation plant, a concrete compost pit, a concrete dam, and a telephone line from Lamao to Limay; this legislation made possible the completion of the equipment and the present expansion of the work.

Under the reorganization plan the work of Lamao was separated in January, 1913, into the following fifteen projects: Tropical fruits, citrus fruits, pineapples, avocados, mangos, papayas, spices, nursery work, tropical rootcrops, vegetables, seed growing, apiculture, live stock, maintenance, and extension. The following is a brief summary of the work accomplished on each project to date.

Tropical fruits.—This project has necessarily occupied more time and attention than any other, and comprises all the tropical and subtropical fruits excepting those that have been made the subjects for separate projects.

One of the main features of the work has been the establishment of a collection of most of the tropical fruits found in the Philippines and the introduction of a large number of fruits heretofore not cultivated in the Archipelago, for which purposes three fields in the station have been reserved. Including the species already mentioned, most of which were transplanted to the new site, the tropical-fruit arboretum at the end of 1913 contained the following species:

Chico-mamey, *Lucuma mammosa;* mabolo, *Diospyros discolor;* zapote negro, *D. ebenaster;* casimiroa, *Casimiroa edulis;* tamarind, *Tamarindus indica;* barobo, *Diplodiscus paniculatus;* guava, *Psidium guajava;* genipap, *Genipa americana;* yaruma, *Cecropia palmata;* date, *Phoenix dactylifera;* iba, *Cicca disticha;* hevi, *Spondias cytherae;* rambutan, *Nephelium lappaceum;* bobog, *Sterculia foetida;* pangui, *Pangium edule;* yambo, *Eugenia jambos;* duhat, *E. jambolana;* phalsa, *Grewia asiatica;* bael, *Aegle marmelos;* vilatti, *Feronia elephantum;* kayam, *Inocarpus edulis;* biriba, *Rollinia orthopetala;* caraunda, *Carissa carandas;* pulasan, *Euphoria mutabile;* macadamia, *Macadamia ternifolia; Fla-*

courtia cataphracta; kambog, *Dillenia speciosa;* pomegranate, *Punica granatum;* durian, *Durio zibethinus;* cherimoya, *Annona cherimolia;* sugarapple, *A. squamosa;* mamon, *A. glabra;* soursop, *A. muricata;* and custardapple, *A. reticulata.*

The following species were planted in 1914: feijoa, *Feijoa sellowiana;* kaffir plum, *Aberia caffra;* ketembilla, *A. gardnerii; Britoa acida;* cattley guava, *Psidium cattleianum;* cos, *P. friedrichsthalianum;* guisaro, *P. molle;* carissa, *Carissa arduina;* Barbados cherry, *Malpighia glabra;* akee, *Blighia sapida;* ceriman, *Monstera deliciosa;* hog plum, *Spondias lutea;* alubihod, *S. mangiferae;* nelli, *Phyllantus emblica;* tiessa, *Lucuma rivicoa* var. *angustifolia;* caymito, *Chrysophyllum cainito;* banauac, *Uvaria rufa;* carambola, *Averrhoa carambola; Vangueria edulis;* juany, *Mangifera odorata;* breadfruit (rima), *Artocarpus communis* (seedless); marang, *A. odoratissima.*

The following species were planted in 1915: seagrape, *Coccoloba uvifera; Coccoloba* sp. (from Nicaragua); catmon, *Dillenia philippinensis;* hondapara, *D. indica;* grumichama, *Eugenia brasiliensis;* macopa, *E. malaccensis; E. edulis;* pitanga, *E. uniflora;* lipoti, *E. curranii;* macupa, *E. javanica; Eugenia* sp. (from Philippines); bignay, *Antidesma bunius;* camia, *Averrhoa bilimbi;* santol, *Sandoricum koetjape;* mastic, *Sideroxylon mastichodendron;* icaco, *Chrysobalanus icaco;* lemoncito, *Triphasia trifoliata;* cubili, *Cubilia blancoi;* soncoya, *Annona purpurea;* anigli, *A. senegalensis; Rollinia* sp. (from South America); calumpit, *Terminalia edulis;* bilucao, *Garcinia bilucao;* wampi, *Cookia punctata; Rheedia edulis;* alacao, *Palaquium philippinense;* Brazil nut, *Bertholletia nobilis;* litchi, *Litchi chinensis;* longan, *Nephelium longanum;* pili, *Canarium ovatum;* chico, *Achras sapota* var. St. Croix; *Psidium laurifolium;* rambi, *Baccaurea motleyana;* Barbados gooseberry, *Pereskia aculeata;* gomihan, *Artocarpus elastica;* jak, *A. intergrifolia;* lanzon, *Lansium domesticum;* granadilla, *Passiflora quadrangularis; P. laurifolia;* bitungol, *Flacourtia sepiaria;* and salak, *Zalacca edulis.* This makes a total collection of 93 species of fruits without including the citrus fruits, pineapples, mangos, avocados, Muscadine grapes and papayas.[1]

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[1] To the very great interest in plant-introduction work of Mr. O. W. Barrett and the generosity of botanical institutions abroad is due a very large share of the plant collection at Lamao. The Siamese pomelos and various interesting plants were procured by Mr. H. H. Boyle, formerly assistant horticulturist. Until 1913 practically all the seeds received by the Bureau were propagated at the Singalong experiment station and the plants later shipped to Lamao.

A small orchard of the seedless breadfruit has also been planted in order to provide propagation material of this valuable fruit in the future, and some 30 plants of the marang, *Artocarpus odoratissima,* in the hope that some plants of this delicious fruit may become acclimatized here.

Seventy plants of the following Muscadine grapes, introduced during 1913–14, were planted in the field in 1915: James, Thomas, Eden, Lasalle, Mish, Labama, Flowers, Scuppernong, San Melaska and San Jacinto. These varieties were interplanted with male Muscadine vines which were introduced in order to insure fruiting. (See this REVIEW, Vol. VI (1913), No. 1, p. 28.)

Among the fruits planted up to 1914, the genipap, yaruma, bael, carissa, caraunda, cattley guava and *Flacourtia cataphracta* have fruited.

Several budded cherimoya varieties have been introduced for propagation and dissemination to the higher elevations and for hybridization with the lowland annonas, such as the sugar apple, custardapple and soursop. Grown on mamon stocks these cherimoyas have made fair progress. Three varieties of superior budded guavas have also been introduced.

Seeds obtained by crossing the sugarapple and cherimoya in Miami, Florida, U. S. A., were brought to the Philippines in 1911 by the writer, from which 24 hybrid seedlings were raised and planted at Lamao. One of these fruited in 1913 and 19 more fruited for the first time in 1914, yielding about 200 fruits. When the atemoyas, as the hybrids have been named, bloomed, they were crossed with the "Giant" cherimoya from Australia, the sugarapple, and the custardapple, with the result that there are now growing at the station 17, 21 and 73 hybrids, respectively, of these new combinations and 261 second generation atemoyas.

All the atemoyas were disappointingly small. The quality of the one which fruited in 1913 was excellent; of those that fruited in 1914 none was inferior to the sugarapple, while several were distinctly superior and more or less intermediate in quality between the cherimoya and sugarapple. Both the atemoya and the cautemoya, as the custardapple-atemoya seedlings have been named, are of exceptional vigor; the other two combinations about equal the sugarapple in vigor.

One hundred seedlings of the hevi and 128 of the banauac, and smaller numbers of various other species have been planted for breeding and selection work. Sweet-fruited varieties of the camia and carambola, and a superior variety of santol have been established by means of budding.

The Victor and Rico roselle, introduced in 1911, and the Archer, introduced in 1913, have been improved; one variety, the Temprano, 20 days earlier than the ordinary kinds, was isolated in 1911 and named in 1914, after three seasons' selection and testing. What is apparently an accidental hybrid of value between the Rico and Victor has been isolated during the past season. Yield tests of herbage and fruit of roselle were made in 1912 in connection with the Bureau of Science experiments in making wine and fruit syrups from the herbage. (See this REVIEW, Vol. VI (1913), No. 5, p. 223.)

In order to pave the way for their standardization, and to make possible the propagation of individual superior trees, considerable attention has been paid to experimental work in asexual propagation of exogenous tropical fruits, chiefly with shield budding, this being considered the most desirable of all methods. (See Current Notes, p. 135.)

In the course of this work a successful method of propagating the seedless breadfruit (rima) has been discovered, and in the following species the feasibility of shield budding has been demonstrated and the details of procedure worked out: cacao, *Theobroma cacao;* cashew, *Anacardium occidentale;* durian *Durio zibethinus;* carambola, *Averrhoa carambola;* casimiroa, *Casimiroa edulis;* camia, *Averrhoa bilimbi;* duhat, *Eugenia jambolana;* genipap, *Genipa americana;* hevi, *Spondias cythereae;* santol, *Sandoricum koetjape;* barobo, *Diplodiscus paniculatus;* phalsa, *Grewia asiatica;* seagrape, *Coccoloba uvifera;* hondapara, *Dillenia indica;* vilatti, *Feronia elephantum;* nelli, *Phyllanthus emblica;* bignay, *Antidesma bunius;* calumpit, *Terminalia edulis;* mabolo, *Diospyros discolor;* iba, *Cicca disticha;* bael, *Aegle marmelos; Flacourtia cataphracta;* and banauac, *Uvaria rufa.* The possibility of shield budding the following additional species has also been proven: ketembilla, *Aberia gardnerii;* cattley guava, *Psidium cattleianum;* zapote negro, *Diospyros ebenaster;* alupag, *Euphoria cinerea;* Barbados cherry, *Malphigia glabra;* bitungol, *Flacourtia sepiaria;* catmon, *Dillenia philippinensis;* and feijoa, *Feijoa sellowiana.*

The lanzon has been grafted as well as shield budded. In budding experiments with *guttiferous* plants it has been found that the Palo Maria, *Calophyllum inophyllum,* can be shield budded, and it is worthy of note that the mangosteen takes on *Garcinia venulosa,* though the buds failed to make growth.

It has also been demonstrated that the custardapple can be budded on the sugarapple and soursoup, the biriba, *Rollinia orthopetala,* on the mamon, *Annona glabra,* soursop, custard-

apple and *Annona montana*. The orange, pomelo, mandarin, lemon, lime, and citron have been found to take well and make a good growth on the calamondin, *Citrus mitis*. These citrus fruits have also been recently budded on the cabuyao, *Citrus histrix*.

In the course of the above experiments it has developed that certain species, in order that the work may be successful, require that the leaves shall have been removed from the budwood, while still on the tree, sufficiently in advance of the performance of the budding to permit the formation of a well-healed leaf scar; in other species one of the essential points is that the budwood and the stock at the point of insertion be of approximately the same age and appearance; a species may require the observance of one or both these rules; finally, in a third class, including by far the largest number of species, the plants are indifferent whether or not these conditions are observed. In so far as the writer's experience goes, the first class, containing species that require the use of non-petioled, well-matured budwood, includes the mango, cacao, cashew, etc.; here belong also the annonaceous plants, the budwood of which should be sufficiently matured to have completely lost its green color. The second class includes those in which the budwood and the stock at the point of insertion should be of approximately the same age and color; namely, the mango, cacao, hevi, cashew, santol, etc.; in some of these species, for instance in the mango and hevi, the budwood, though ripe, is green, but in most species it changes to another color. The third class, containing those species of which budwood with the adhering petioles may be used, includes among others the citrus fruits, guava, tamarind, carambola, barobo, etc.

Citrus fruits.—The mandarin is one of the commercially important fruits in the Philippines, and there is every reason to believe that some of the other citrus fruits would also become of equal importance if good varieties were introduced and, together with the best Philippine types propagated by budding, planted in suitable localities and properly handled. Considering also the enormous wealth of original forms of the genus *Citrus* in the Philippines, the citrus fruits have therefore been accorded attention second only to the tropical fruits.

It has already been noted that during 1910 plants of the Bahia, Mediterranean, Navelencia, and Washington Navel orange, and the Belair, Lisbon and Villafranca lemon varieties were introduced from Australia and planted at Lamao.

A study of the Philippine citrus fruits by the writer in 1911

showed the urgent necessity of further importation of the standard citrus varieties cultivated in other countries, and during 1912, 1913 and 1914, the following citrus varieties were imported:

Oranges: Bessie, Boone, Brown, Centennial, Enterprise, Everbearing, Excelsior, Holdfast, Homosassa, Joppa, Larrantta, Majorca, Malta Blood, Maltese oval, Nonpareil, Paperind, Pineapple, Ruby, Tardiff, St. Michaels, Blood, Navelencia, Valencia, Vini, Vinous, White Siletta, St. Jago, Foster, Carleton, Magnum Bonum, Duroi, Dugat.

Pomelos: Royal, McCarthy, Walters, Duncan, Ellen, Marsh, Pernambuco, Siam, Triumph.

Mandarins: China, Dancy, King, Kishiu, Ladu, Oneco, Satsumamikan, Suntara Nagpur, Unshiu.

Lemons: Messina, Lisbon, Lisbon variegated, Sicily, Thornless.

Limes: Bengal, Tahiti, Everglade, Trinidad.

Tangelos: Sampson.

Four varieties of the mandarin, four of the tizon and one pomelo of Philippine origin have been found that merit general dissemination and are being propagated for distribution.

Owing to the fact that practically nothing was known relative to the wild or semicultivated citrus forms in the Archipelago, an attempt has been made to assemble these forms at Lamao both for the purpose of identification and to determine their economic value. A large collection, containing 141 serial numbers of Philippine citrus trees, has been planted, including the following species: *Citrus aurantium* L., *C. vulgaris* Risso, *C. nobilis* Lour., *C. nobilis* var. *papillaris* Blanco, *C. decumana* L., *C. mitis* Blanco, *C. webberii* Wester, *C. webberii* var. *montana* Wester, *C. longispina* Wester, *C. southwickii* Wester, *C. macrophylla* Wester, *C. histrix* DC., *C. histrix* var. *torosa* Blanco, *C. histrix* var. *boholensis* Wester, *C. micrantha* Wester, *C. micrantha* var. *microcarpa* Wester, *C. medica* L., *C. medica* var. *odorata* Wester, *C. medica* var. *nanus* Wester, *C. limonum* Risso, *C. pseudolimonum* Wester, *C. limetta* Risso, *C. limetta* var. *aromatica* Wester, *C. excelsa* Wester, *C. excelsa* var. *davaoensis* Wester.

Aside from those lots that belong to the above-named species there are a number of forms, the plants of which are still too small to admit of their identification, some of which may belong to other species. For full descriptions of the species mentioned see this REVIEW, Volume VIII (1915), No. 1, page 5.

The imported varieties as well as a few Philippine kinds of merit are mostly budded on the sweet orange and pomelo. A few have been budded to various native citrus stocks, such as the calamondin, *C. mitis*, alsem, *C. webberii*, *C. excelsa* var. *davaoensis*, etc. The budded trees have been planted in an

orchard, 2 trees of each variety 4 x 8 meters apart. The seedling trees are planted 3 by 4 meters apart, 1 to 20 of each lot, for testing and observation depending upon individual variation and its hypothetical horticultural value.

Pineapples.—This is one of the minor projects, and the work has been confined to the introduction and planting of Cayenne and the Spanish from Hawaii, the Abakka, Cabezona, Sugarloaf, and several hybrids, among others the Eden and Deliciosa, from south Florida. As previously stated the Queen was introduced some years ago.

There are now growing at Lamao approximately 2,000 Queen, 2,000 Cayenne, 1,000 Spanish, 200 Sugarloaf and some 300 plants including all the other varieties mentioned. Of these the Queen, Cayenne and Spanish have made excellent growth and shown themselves well adapted to the climate and soil. The Cayenne particularly comes up to all anticipations and this variety is so superior to all others for home consumption and canning that they cannot even be considered as its competitors under equal conditions. The principal use of the Spanish would seem to be for exportation of fresh fruit to Hongkong, China and Japan.

The remaining varieties have not shown the adaptability of those just mentioned, though fair progress has been made by the Abakka, Sugarloaf and Eden. It is hoped that at least the two first-named varieties may adapt themselves to the country, since because of their late fruiting habit they would prolong the pineapple season several months.

Avocados.—This fruit was made a separate project more because of its potential than its present and actual value to the Philippines. As already stated a small avocado orchard was planted at Lamao some years ago. Most of these trees have fruited, but only two have borne sufficiently meritorious fruit to be worthy of propagation, one of which was named and propagated for distribution last year.

Budwood has been received of named varieties from Hawaii, California and Florida, including several of the best avocado sorts in these countries and has been successfully budded with the result that the station now has 34 budded varieties, most of which have been received from the United States Department of Agriculture.

Mangos.—Due to the fact that the ordinary Philippine seedling mango is already a superior fruit, comparatively little attention has been paid to it, especially considering that the mango is one of the most common fruits in the Archipelago.

A recent improvement in the budding of the mango has been

made by demonstrating definitely the advantage of using non-petioled instead of petioled budwood (see this REVIEW, Vol. VIII (1915), No. 1, p. 59), in connection with which it may be of interest to know that the juany, *Mangifera odorata* Griff., shield budded on the mango by Mr. H. H. Boyle is making excellent growth on this stock.

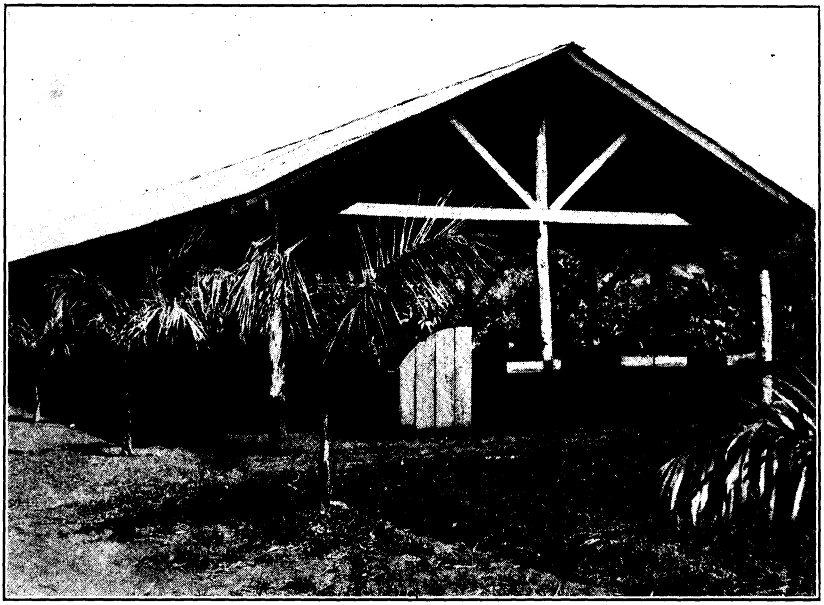
The following inarched varieties have been imported from India and are now well established: Naspati, Gopalbhog, Tamancha, Krishna Bhog, Sandurea, Chickna, Bombay green, Alfonso, Malda, Kachamitha, Davy's Favorite, Langra, Kutna, Salibunda, Sufaida, Kakaria, Surkha and Najibabadi Amin.

Papayas.—A large papaya orchard has been maintained year after year for seed production and distribution, and now includes 314 plants. All males and all undesirable pistillate trees are being destroyed as soon as their true characters appear and seed is sown from the best hermaphrodite fruits. The result of this simple method of improving the strain, within reach of every papaya grower, is that an unusually good strain has been developed within a very short time and is gradually becoming disseminated throughout the Archipelago.

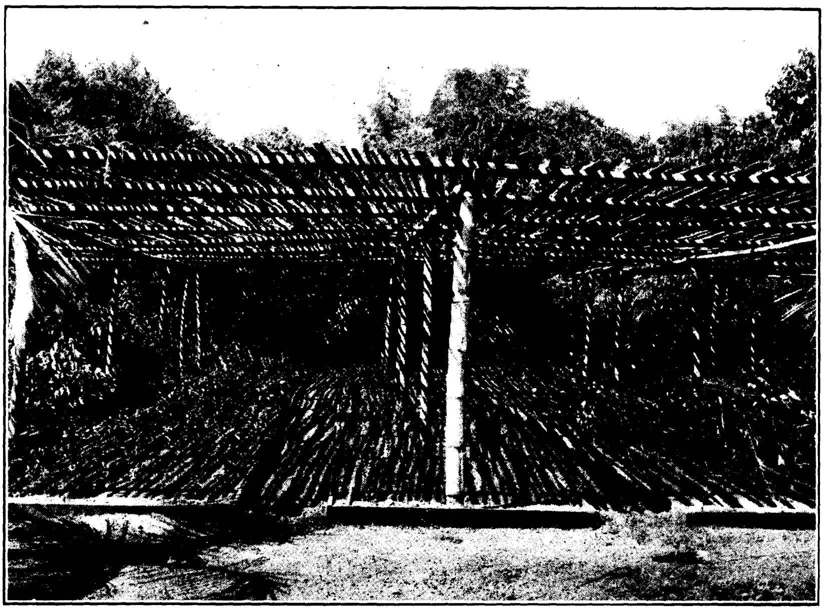
Spices.—It cannot be doubted but that spices in certain parts of the Islands would be a profitable crop; ginger and black pepper are indeed grown here and there. The long dry season and the short wet season with a very heavy rainfall, characteristic of Lamao, is not well suited to most spice plants, and the planting in the field of the vanilla and cardamon resulted in the failure of both though the plants were strong and vigorous, and the project is temporarily suspended.

Nursery work.—With the erection of up-to-date propagating houses, the installation of an adequate irrigation plant, and the improvement of the surface irrigation system, the nursery operations have increased from the propagation of some 700 plants in 1911 until, at the end of the year 1914, the nursery at Lamao contained the following plants:

Citrus trees of standard varieties, budded	2,548
Annonaceous plants, budded	373
Avocados, budded	160
Tropical fruits, seedlings, miscellaneous species	5,537
Annona hybrids	364
Citrus stocks, various species	8,269
Annonaceous stocks	1,629
Miscellaneous economic and ornamental plants, not fruits	4,825
Total	23,705



(*a*) Plant propagation shed, Lamao Experiment Station, 1914.



(*b*) Section of bamboo plant propagation shed, Lamao Experiment Station, 1915.

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(*a*) Main road leading from Manila Bay to the experimental fields, Lamao Experiment Station, 1914.

The office building on the right, and the residence of the superintendent, on the left, are concealed by the shrubbery.

(*b*) Road through citrus orchard and nursery, Lamao Experiment Station, 1914.

(*a*) Road through nipa swamp from office and residence to experimental fields, Lamao Experiment Station, 1914.

(*b*) Seed-growing, Lamao Experiment Station, 1914—"India" cucumber in the foreground, seguidilla, *Psophocarpus tetragonolobus*, and lima beans in the background.

During the same year, 1914, the plant distributions were as follows:

Citrus trees, standard varieties, budded	813
Atemoyas, budded	37
Tropical fruits, seedlings, miscellaneous species	1,305
Citrus stocks	183
Pineapple suckers and slips	16,153
Maguey suckers	16,600
Yams (tubers)	1,045
Mulberry cuttings	6,000
Miscellaneous cuttings	200
Citrus scions (22 varieties)	196
Total	42,532

From July 1, 1912, to December 31, 1913, 294,300 maguey suckers and bulbils were distributed but the demand has now lessened to such an extent that the upkeep of the maguey field has been largely abandoned; likewise, with the diminished demand for mulberry cuttings (of which 28,000 were distributed during the year ending June 30, 1913) the old mulberry plants have been gradually removed and superseded by some 75 plants of the best white mulberries imported from France.

Tropical rootcrops.—This project is confined to yams. A few yams had been grown for observation, and a small collection was sent to Lamao early in 1911, but no particular care was given these plants and practically all were lost. During the First Philippine Exposition in Manila (February, 1912), the writer procured a large collection of yams including *Dioscorea alata, D. aculeata* var. *tiliaefolia, D. pentaphylla,* and *D. triphylla* from the provincial exhibits, some of which had unusually good yam collections. Most of the tubers included in this lot were sent to Lamao, while a small duplicate collection was set out at the Singalong experiment station. During 1912 and 1913 it was increased by a number of Philipine and foreign accessions until at the present date the yam collection at Lamao includes over 70 accession numbers. Many of these lots are, however, necessarily duplications of each other.

At the end of each season the tubers were replanted until, in 1914, 0.5 hectare was devoted to yams. With the analyses being made by the Bureau of Science, the records kept of the behavior of the plants, and with the elimination of the less desirable types, the preliminary testing work will be completed before the planting season for 1915 shall have opened, and the future work will consist largely in the propagation of the desirable forms. It is already evident that of the various species now found in

the Archipelago only *Dioscorea alata* and *D. aculeata* var. *tiliaefolia* are worthy of cultivation. There are, however, several extra-Philippine species of excellent qualities whose introduction would unquestionably be desirable.

Vegetables.—The vegetable tests in 1913 included 95 table beans, 12 varieties of cucurbits and 12 varieties of sweet corn. The bean trial was particularly interesting and showed that several varieties might be profitably cultivated in the Philippines. The yields per hectare of the six most promising varieties, according to records kept by Mr. Kingman, were as follows: Early Mohawk, 1,388 kilograms; Dwarf Horticultural, 892 kilograms; Round Yellow, 832 kilograms; Wardwell's Kidney Wax, 573 kilograms; Black Valentine, 545 kilograms; and Dreer's White Wax, 527 kilograms. These yields were computed from small plats grown of each kind and the yields probably would be 10 to perhaps 15 per cent lower in field culture.

The sweet corn made a stunted growth but several varieties produced ears of excellent quality.

The forage and cover-crop trials, started in 1911 and continued through 1912, were concluded in 1913 with a test of 62 separate varieties in which were eliminated all legumes included as cover-crops for the Philippines excepting the Lyon bean, the New Era cowpea, 3 varieties of mungos, the guar and the Florida Beggarweed. The New Era cowpea yielded seed at the rate of 1,055 kilograms per hectare. A detailed account of the vegetable and forage trials above referred to was prepared by Mr. Kingman who was in charge of this work. It appears elsewhere in this issue of the Review.

During the season 1913 and 1914, 22 imported varieties of cucurbits, 9 varieties of okra and a few bean varieties were tested, none of which yielded anything worth further trial. Among the climbing lima beans the most promising is a white variety obtained by the writer in 1912 in Bukidnon, Mindanao, where it is said to grow wild in the mountains; in fact this is the only lima that has been retained as worthy of future breeding work. The India cucumber, named and described in this REVIEW, Vol. VII (1914), No. 2, page 80, is the only cucurbit that has been found worthy of distribution.

Seed growing.—This project may be said to have been begun in 1910, when large quantities of Lyon beans, okra and papaya seed, and some liberian and robusta coffee were first grown for distribution. Since then seed growing has been part of the station activities and seed in greater or less quantities has been produced for distribution annually through the central office

of the Bureau in Manila. The list of these seeds includes the following plants: Lyon beans, New Era cowpeas, mungos, table beans (several varieties), seguidillas, okra, roselle, papaya, corn, cadios and cucumber. Most of the seed crops are cowpeas and Lyon beans, and since these plants are grown as cover crops between the trees in the orchards, they serve a twofold purpose with practically no additional cost except the harvesting of the seed. This year all the tillable land not otherwise occupied is planted to cowpeas, guar, seguidillas, corn and cucumbers, something more than a hectare being devoted to this last mentioned crop. During the last four years the practice has been to annually plant Lyon beans before the advent of the rainy season on land not occupied with other crops and to harvest them shortly after the beginning of the dry season. After the harvest of the Lyon beans the land is then planted to cowpeas, corn, etc. Two successive crops of cowpeas, for instance, are easily harvested in one dry season on the same land.

The cowpea and Lyon-bean vines, etc., are used either as mulch around the trees or plowed under.

Apiculture.—Six hives of bees, imported from Hawaii and Guam, were transferred from the Singalong experiment station to Lamao in December, 1912, but the colonies failed to thrive and the project is temporarily suspended.

Live stock.—Before the reorganization of the station this project covered all animal breeding work conducted at Lamao; at the present time it covers only the work animals (six Chinese bullocks) and their care.

Maintenance.—To this project is charged all expenditures for repair of buildings, the upkeep of fences, roads, etc., and transportation between Lamao and Limay.

Extension.—This covers all work not directly related to any of the above mentioned projects, such as construction work, drainage, or clearing of new land, etc.

Since December, 1912, nine young men have received practical training in horticulture at Lamao before being detailed to the provinces by the Demonstration and Extension Division of this Bureau.

The writer wishes to express his appreciation for the loyal support received from his coworkers and subordinates, which has made possible the accomplishment of a remarkable amount of work in a comparatively short space of time. Particularly appreciated are the services of Mr. F. C. Kingman, to whom fell much of the detail work in connection with the reorganization of the station, who was in full charge of the construction

work, and who directed the labor during 1912, 1913 and 1914. Up to December, 1914, all experimental work in asexual propagation of tropical fruits was conducted in person by the writer; since then, with the extension of the work to a large number of species, most of the work has been performed by Mr. Francisco Galang, Mr. Severo Capistrano and Mr. Bernabé Malvar, agricultural inspectors.

During the earlier years of the existence of the station much time was necessarily occupied in clearing the land, and the changes that have been made during the last three years, together with the construction work, have left comparatively little time for experimentation. This labor is now practically completed, making the future work largely routine and experimental until the cultivable area is extended. A nucleus of plants has also been assembled which, together with what is readily procurable in the Philippines or neighboring countries, will provide good working material for many years to come.

By these permanent improvements made within the last three years, the actual and particularly the potential value of the Lamao experiment station is now greater than that of any other of the plant industry experiment stations maintained by the Bureau of Agriculture in the Philippine Islands. Land of good quality, easily and cheaply irrigated, is available in areas sufficient to meet any demand for extension. With the construction of the concrete dam and the new ditches completed last year, an area twice as large as the present one can be brought under cultivation without further irrigation expense than that of digging the necessary laterals, and still greater enlargements of the tillable area for several years would merely require the deepening and widening of the main ditch. The location for a laboratory and residences for the workers is ample, attractive, practically free of mosquitoes throughout the year, and, being located on the seashore, is much cooler than the interior of the Islands. Everything considered, should it appear desirable to concentrate the plant industry research work of the Bureau at any one point, so far as the climatological requirements of the plants will permit and with a view to increasing efficiency and reducing expenses, the Lamao experiment station is the logical point for such concentration.

VEGETABLE AND COVER-CROP TRIALS AT THE LAMAO EXPERIMENT STATION.

By F. C. KINGMAN, *Agricultural Inspector.*

In the work of seed distribution the Bureau of Agriculture has, for a number of years, obtained the larger portion of its seeds from a seedhouse in Australia. Considerable quantities of seeds have also been purchased from various firms in the United States and Europe, with the object in view of determining their relative value, as shown under test, so that, in the future, preference may be given to those firms whose seeds have shown the best results in the tests. In addition, it was hoped to discover some varieties which would be particularly adaptable to Philippine conditions, making it possible to grow them in large quantities for use in the seed-distribution work of the Bureau; for, aside from the expense incident to the purchase of seeds from abroad, they have not always been in good condition upon their arrival here and they deteriorate rapidly in germinative power in this climate. It was believed that this difficulty might be largely overcome if a more or less constant supply of home-grown seeds was available. Accordingly, ninety-five varieties of table beans, nine varieties of cucurbits and ten varieties of sweet corn were sent to the Lamao experiment station to be tested with reference to cultural methods, edibility and productiveness.

The tests were begun in the month of December, 1912, continued through the cool season and concluded toward the close of the dry season in 1913. The season of the year apparently had no detrimental effects upon the growth of the table beans, cover crops and sweet corn, but the poor results obtained from the cucurbit trials were largely due to lateness of planting.

The preparation of the seed beds for the various tests was practically the same. The soil was first irrigated and, after a few days when sufficiently dry, it was plowed, disked, harrowed and smoothed with a plank drag. All varieties of table beans were sown thinly in drills with the rows 60 centimeters apart,

the cucurbits in hills 2 meters apart each way, the corn in check rows 1 meter apart each way, and the cover crops thinly in drills 1 meter apart. Exception was made with some of the mungos, however, they being sown in the same manner as the table beans and the Lyon beans which were given a distance of $1\frac{1}{2}$ meters each way. In planting the table beans and a few varieties of the mungos, a marker, made like a large rake with teeth every 60 centimeters, was used. This implement, when dragged over the field, marked out the rows which were later furrowed out with a plow. The seed was then sown and covered with the hoe. In planting the varieties of sweet corn and cucurbits a similar marker was used which check-rowed the former in hills 1 meter each way and the latter in hills 2 meters each way. The cowpea cover crops were drilled in, in rows 1 meter apart, a plow being used to open the furrows. In planting the Lyon beans as a cover crop, a marker was used and the beans planted in hills $1\frac{1}{2}$ meters apart each way, 2 to 3 beans to the hill. The sowings of table beans were started during the latter part of December and continued from time to time, as the seeds were received, until as late as May.

As all the tests were conducted during the dry season, irrigation was necessary on an average of every ten days. This was accomplished by flooding the plots with water from an open ditch. For the sweet corn, cucurbits and all tests where the planting was made in rows 60 centimeters apart, a fire-shovel cultivator was used for cultivation purposes. However, in some instances, where the nut grass was very bad, it was necessary to use hoes. It was the custom to cultivate a few days after irrigation, just as soon as the soil was sufficiently dry. In cultivating the cowpeas and Lyon beans a twelve-tooth cultivator was used. The Lyon beans received little or no irrigation. The pole varieties of table beans required the making of trellises which was accomplished by setting bamboo posts 2 meters in length along the rows at intervals of 4 meters, and attaching to these, with bejuco, two bamboo strips running horizontally, one about one-half meter above the other.

Notes were taken on all the table-bean varieties showing the source (seed house), date of planting, germination, stand, habit of growth, flowering, date edible, date of maturity, productiveness, vigor, average length of pods, average thickness of pods, average number of beans in pods and amount of fiber. In a number of plots where, due to the previous leveling of some of the fields, the surface soil had been removed thus exposing the

acid subsoil, the plants under these adverse conditions, in most cases, made a very poor growth. In other plots where it was difficult to control the nut grass, a number of varieties also made a poor growth. It is very likely that some of the varities grown under the conditions just mentioned were not inferior in vigor but made a poor showing because of the poor soil conditions. The following six varieties, considered the best, were selected and their yields per hectare computed:

		Kilos.
L-54.	Wardell's Kidney Wax beans	573.75
L-56.	Black Valentine beans	545.50
L-59.	Early Mohawk beans	1,156.00
L-61.	Dreer's White Wax beans	527.62
L-62.	Dwarf Horticultural beans	892.50
L-63.	Round Yellow beans	823.80

Thirty different kinds of cover crops were tested as given in the following list:

Lyon beans.
P. I. 1669. Soy bean.
New Era cowpeas.
Clay cowpeas.
L. 53. Iron cowpeas.
Brabham cowpeas.
Groit cowpeas.
P. I. 665. Peanuts.
Guar (*Cyamopsis psoralioides*).
L. 10. *Lathyrus tingitanus.*
P. I. 2398. *Vicia faba.*
P. I. 2400. *Lens esculenta.*
P. I. 2399. *Cicer arietinum.*
P. I. 2401. *Cicer arietinum.*
P. I. 1585. *Stizolobium deeringianum.*
P. I. 1586. *Stizolobium aterinum.*
P. I. 278. *Phaseolus calcaratus.*
P. I. 1534. *Phaseolus calcaratus.*
P. I. 279. *Phaseolus mungo.*
P. I. 1112. *Phaseolus mungo.*
Phaseolus mungo.
P. I. 1195. *Phaseolus* sp.
P. I. 1952. *Phaseolus* sp.
P. I. 2056. *Phaseolus* sp.
Phaseolus sp., No. 1.
Phaseolus sp., No. 4—Iloilo.
Phaseolus sp., No. 7.
P. I. 2470. *Phaseolus* sp., Japanese.
Phaseolus aconitifolius.
P. I. 1951. *Phaseolus vulgaris.*

The Lyon beans gave excellent results, forming a thick dense growth over the ground and effectually choking out weeds. Part of the guar germinated very poorly and a good stand was not obtained from more than one sowing. However, judging from the growth of the plants where the stand was good, this legume promises to give excellent results as a cover crop. The remaining cover-crop legumes in the list tested gave unsatisfactory results and were discarded.

Of the cowpeas, the New Era far outranked the others in vigor of growth, ability to cover the ground and in seed production. The Clay cowpeas came next, followed by the Iron and Brabham in the order named. The Iron and Brabham cowpeas made a very poor growth and were discarded. Representative areas

were selected of both the New Era and Clay varieties and their yields per hectare computed as follows:

	Kilos.
New Era cowpeas	1,065
Clay cowpeas	804.67

Four varieties of mungos, one green seeded, one black seeded and two yellow seeded, gave good results as cover crops. They covered the ground well, choked out the weeds and, in addition, gave good yields of seed. The yields of seed per hectare were as follows:

	Kilos.
Green-seeded mungos	530.5
Black-seeded mungos	623
Yellow-seeded mungos	748.2
Iloilo No. 4 Yellow-seeded mungos	801.4

The varieties of cucurbits tested were as follows:

No. 16. Watermelon.
No. 17. Squash, Early white bush scallop.
L–66. Muskmelon, Rocky Ford.
L–67. Squash, Fordhook.
L–68. Muskmelon, Large yellow.
L–69. Cucumber, India.
L–70. Squash, Mammoth summer.
L–71. Squash, Yellow summer crookneck.
L–72. Watermelon, Cole's early.

Due partly to planting late in the season (January), but mainly to the voracious attacks of insects, the cucurbit trials were failures, with one exception. The plants were frequently dusted with a mixture of Paris green and lime but this failed to hold the insects in check. One variety of cucumber, however, introduced from India (L–69 "India"), was apparently quite resistant to the insect attacks and did very well, producing an abundance of fruit. Four and one-half kilos of seed were harvested from an area of approximately 200 square meters.

The following varieties of sweet corn were planted January 15, and first picked for eating April 12.

L–83. Early white Cob, Corey.
L–84. Golden Bantam.
L–85. Golden Cream, Morse.
L–269. Black Mexican.
S–270. Golden Dawn.
S–271. Dreer's Golden Cream.
S–272. Dreer's First-of-all.
S–378. Early Minnesota.
S–382. Early Red Cob, Corey.
S–433. Stabler's Early.

The germination and stand of these varieties of sweet corn were excellent. All made a stunted growth but the production of ears was quite satisfactory, being of good length and well filled out. Notwithstanding the poor growth of the plants, the eating tests showed the quality of the corn to be excellent. The ears produced were very tender and sweet. Regarding yield, size of ears and quality of ears, the best varieties rank as follows:

S-271. Golden Cream.
S-378. Early Minnesota.
S-270. Golden Dawn.
S-272. Dreer's First-of-all.
S-433. Stabler's Early.

Conclusions.—Although experiments conducted for only one season are inconclusive, the results obtained from the table-bean trials aparrently indicate that some of the varieties can be grown successfully in the Philippines.

The large yields of seed from such varieties as Early Mohawk, Dwarf Horticultural and Round Yellow beans would seem to indicate that these varieties could be profitably grown for seed production.

Judging from the results obtained from the cover-crop trials the following six legumes may be recommended for that purpose:

Lyon bean.
New Era cowpea.
Guar.
Yellow-seeded mungo.
Black-seeded mungo.
Green-seeded mungo.

Where the climbing habit of the Lyon bean is not objectionable, it is, perhaps, the premier cover crop during the rainy season. Of the cowpeas tested, only one, the New Era, has been retained for future planting. The Clay cowpea did very well but the New Era is so far superior that, if obtainable, it should be given the preference. The remaining varieties have been discarded. As the New Era cowpea gave an abundant yield of seed, 1065 kilos per hectare, the growing of this legume for seed production may be recommeded.

The planting of the cucurbits late in the season and the consequent attacks of insects were responsible for the almost total failure of these trials. Only one variety survived the insect attacks and fruited well.

The good results obtained from several varieties of sweet corn are worthy of notice and encourage further tests of this crop.

SIRUP MANUFACTURE.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

The manufacture of sirup for table use forms a very important industry in many countries, and this product, when properly made, is one of the cheapest and most wholesome articles of food. Sirup has long been considered a delicacy by various peoples, no doubt originally because of its similarity to natural honey, under which name it has often been sold. The varieties and sources of this product are very numerous. Among the most important classes may be mentioned the cane, palm, maple, and corn or glucose sirups.

CANE SIRUP.

This sirup consists of the juice of the sugar cane (*Saccharum officinarum*), boiled to the required consistency after receiving proper clarification, the degree of which will depend upon the original condition of the juice.

There is a wide difference in the purity of cane juices, some containing as high as 90 per cent of the total solids as sucrose while others will have as low as 50 per cent or less. The higher purity ordinarily indicates close proximity to maturity of the cane while the extremely low purity may be the result of several causes among which are: undermaturity, overmaturity, unfavorable weather conditions, windstorms, and injury by animals or insects. The low purity of a cane juice, however, may not always indicate an extremely low yield in sirup, though there is usually some diminution; but it may give a sirup with an entirely different flavor and other characteristics, since a portion of the crystallizable sugar (sucrose) will usually be changed into the invert sugars by a process known as inversion, and may affect the composition of some of the nonsugars. It has been recommended by some sirup makers that this class of cane be used in preference to ripe cane in order to make a sirup in which the sugar will not crystallize out, but this difficulty may readily be overcome in another manner which will be set forth later, and thus the change in other organic compounds may be avoided.

Some varieties of cane will give a lighter colored juice than others and this usually means a lighter sirup, especially when but little attempt at clarification is made. The coloring substance "anthocyan" is ordinarily not all removed by the limited amount of lime used in clarification and the remainder is not readily bleached by the sulphitation. It is therefore usually preferable to reject the darker varieties which contain this soluble pigment in profusion.

In the manufacture of a high grade sirup, only selected cane which is thoroughly ripe should be used. A maximum mill extraction is not best, since undesirable amounts of organic impurities, such as gums, are thus removed with the juice, which will cause a darker sirup with an inferior flavor. The juice from the rolls must be thoroughly strained to remove any large particles of bagasse or cane fiber and other impurities. It is then treated with a small quantity of milk of lime to precipitate some of the organic impurities. After this treatment it is either at once left to settle or first treated with sulphur dioxide gas.

Sometimes, however, this sulphuring of the juice is done before the lime is added. The sulphuring has the effect of raising the acidity of the juice so that more lime may be added to effect clarification. It also serves as a bleaching agent, making a brighter and lighter sirup, and causes the precipitation of some of the impurities. Care must be exercised that not too much of the sulphur gas be used, since an undesirable amount of the sulphites will remain in the sirup which is not permitted by the Pure Food Law.

The clarified liquor, which remains above the impurities, should have a clear amber or straw color and is ready for evaporation. If there are still appreciable amounts of impurities present, this juice should be carefully filtered through bags while the settlings may be filtered through presses and this filtrate be clarified with the original juice.

Where a high grade sirup for direct consumption is made, this work of concentration is always done in open train evaporators (Plate V, *a*) under atmospheric pressure, since the highly desired aromatic flavors are thus preserved while in the vacuum type of evaporator these flavors are greatly impaired. The more modern design of open evaporator (Plate V, *b*) for this work has a steam space usually in the form of coils in the bottom of the evaporator which contain the steam for heating.

Water under atmospheric pressure at sea level boils at a temperature of 100° centigrade but when there is a quantity of sugar and other solid material present the boiling point will be

materially increased, depending upon the density of the solution. At the higher temperatures there is a noticeable amount of the sucrose inverted or changed into glucose, but this causes little harm to the resulting sirup so long as no caramel or burned sugar is produced by superheating.

Where the juice is boiled in kettles by the application of direct flames, there is always more or less caramel formed which is responsible for the bitter taste and dark color of many sirups. This is particularly true of the present method practiced in the older factories of the Philippines. After this evil has once presented itself, it is difficult, if not impossible, to make a good grade of crude sirup possessing the natural flavors of the cane juice.

Where such sirups are diluted and passed through bone-black filters the dark color is of course removed, and the resultant sirup will consist only of sucrose in solution and be equal in all respects to sirup made from a high grade sugar.

A question of very great importance to cane sirup manufacturers is the consistency to which the sirup should be boiled. This quality is often referred to by dealers as "body" and is usually judged quite accurately by men of experience. However, in the manufacture of sirup one should not be content with any "hit or miss" method in determining the density of his product, but should use a gravity spindle, either Baumé or Brix. By the aid of the following table these results may readily be transferred from one to the other.

Table of comparison between Baumé and Brix spindles.

Degree Baumé.	Degree Brix.	Degree Baumé.	Degree Brix.
1	1.8	26	46.8
2	3.6	27	48.7
3	5.4	28	50.5
4	7.1	29	52.5
5	8.9	30	54.3
6	10.6	31	56.2
7	12.4	32	58.1
8	14.2	33	60.0
9	15.9	34	61.9
10	17.7	35	63.8
11	19.5	36	65.8
12	21.3	37	67.7
13	23.1	38	69.7
14	24.9	39	71.8
15	26.7	40	73.7
16	28.6	41	75.6
17	30.3	42	77.7
18	32.1	43	79.7
19	33.9	44	81.8
20	35.7	45	83.9
21	37.6	46	86.0
22	39.4	47	88.1
23	41.3	48	90.2
24	43.1	49	92.3
25	45.0	50	94.4

If the sirup is boiled to 39° or 40° Baumé (73° Brix) or total solids, it will ordinarily meet the requirements of dealers. Since the sirup boiled directly from the clarified juice of the cane will contain a large percentage of sucrose or crystallizable sugar and have a very high purity, there will be very great danger of the deposition of crystals if the sirup is made at all heavy; and again if the sirup is made too light in body there will be great danger of its deterioration by fermentation. If the purity of the sirup is so high that there is danger of crystallization at this density, a part of the sugar may first be crystallized out and removed, after which the sirup is again brought to the desired density, or better still, a part of the sugar may be changed into invert sugar or glucose by hydrolysis. This may be accomplished by the aid of acids, enzymes, heat, or other agents, but the simplest method for factory working is to add to the sirup a small quantity of a strong mineral acid and boil for ten minutes or more. As soon as the sirup has reached the proper consistency it should be placed in well-sterilized new containers and properly sealed while hot. Sirup which has been made under the above conditions should keep indefinitely without any sign of fermentation or deterioration.

PALM SIRUP.

Sirups have been made from the sap of various palm trees by the natives of tropical countries from time immemorial. The plants most commonly used for that purpose were the sugar palm, *Arenga saccharifera,* known in the Philippines as the kaong or cabo negro; the wild date palm, *Phoenix silvestris;* the nipa palm, *Nipa fructicans;* and the palmyra palm, *Borassus flabelliformis,* of the East Indies. In olden times the sirup was made in the very crudest manner for direct consumption and no attempt was made to properly clarify the juice before concentration, nor bring it to a heavy density for better preservation. In modern sirup manufacture it is necessary to boil the sirup to a heavy "body" in order to prevent fermentation setting in during the time of storage, since many palm sirups lend themselves readily to enzymic action subsequent to fermentation.

The sap from many of these palms has a very pleasant flavor when boiled only to a thin consistency, but when it is made heavy this flavor becomes more intense until it ceases to be considered pleasant.

The impurities, consisting mainly of organic nonsugars, impart the pleasant flavor to the sirup, but when they become decomposed upon prolonged heating, as in the case where a heavy

sirup is made, dark colored and stronger compounds are formed with the consequent lowering of the value of the sirup.

Where such sirups are made for the trade and must be stored for a long time, it will be necessary to subject the original sap to a preliminary clarification and to guard as far as possible against its being superheated when the sirup becomes heavy.

Absolute cleanliness throughout every part of the work must be exercised and special attention given to prevent fermentation of the saps before boiling. Such a fermentation would cause the decomposition of the sucrose as well as a change of some of the impurities, thus having the effect of lowering the sweetening power and also impairing the flavor of the final sirup.

In collecting the sap only clean and thoroughly sterilized containers which are made of noncorrosive metal, porcelain, etc., should be used. They should be provided with some form of a cover to prevent foreign substances from entering. Since the saps from the majority of the sacchariferous palms are usually subject to enzymic action, every possible means of minimizing this trouble should be used. In the first place, there must be a regular time for gathering the sap and extreme care exercised that it be not left to stand any longer than necessary without treatment. Usually not more than four to six hours should elapse between the collections and even then some form of germicide should be used to prevent fermentation. While a number of different chemicals will answer for this purpose, the most suitable one under ordinary circumstances will be formalin. An apparatus may very easily be arranged so that a few drops would be added from time to time during the flow of the sap. Calcium hydroxide, or calcium sulphite, may also be mixed very advantageously for this purpose and this would have the additional advantage of aiding in the clarification and precipitation of the impurities.

In clarifying the sap it should be placed in a large container and brought almost to the neutral point or made slightly acidic by the aid of sulphur or carbon dioxide. It should then be heated to the boiling point, cooled and settled, and the clear liquor drawn off. This heating process has the effect of removing some of the impurities, such as albumin and albuminoids, which are coagulated and settle to the bottom.

The sap should now be sufficiently clear for concentration in the usual manner. If there are reducing sugars present, which is usually the case, care should be exercised that the sap be not alkaline during the boiling period, since a dark color will likely appear, which is most undesirable in a high grade sirup.

If it is found that the sirup will have too strong a flavor when brought to the usual density, and at the same time it is not feasible to have it thin on account of the danger of fermentation, some sugar might be crystallized out of a portion and these crystals melted with the clarified juice and concentrated until the sirup is brought to the required density.

As soon as the sirup has reached this point it should be placed in clean air-tight containers and sealed at once. Such sirups should keep almost indefinitely and find a ready market.

MAPLE SIRUP.

Although this sirup can not be produced in the Philippine Islands, owing to the absence of maple trees, a brief description of its manufacture is here given for the sake of comparison with the other methods.

Maple sirup is made from the sap of the sugar maple (*Acer saccharum*) and the allied species of the same genus found growing in temperate climates. The impurities contained in this juice possess a very pleasant flavor and are in fact responsible for the sirup being considered a great delicacy. On this account a highly clarified sirup is not desired, as the distinctive flavor would then disappear, and the sirup would not be unlike any other sirup from highly clarified juices, since the sucrose contained is identical with that of the sugar cane and other sacchariferous plants.

The sap is gathered from the different trees usually twice each day, morning and evening. Where especial attention is given to cleanliness throughout the process and a high grade sirup is sought, the containers which receive the sap at the trees are made of galvanized iron and are provided with covers to exclude leaves, pieces of bark, etc.

As soon as the juice reaches the sugar house it is carefully strained through cloth and evaporated immediately. The apparatus originally used for this work of concentration was simply a series of kettles arranged in a battery, the boiling juice being dipped from one to another during the course of evaporation. In modern maple-sugar houses this work is done in copper or galvanized-iron evaporators containing compartments into which the juice flows by gravity during boiling. They are heated by steam instead of the direct flames, thus minimizing caramelization. Even with this style of evaporator extreme care is exercised in the process of condensation to prevent the sugar solution from becoming superheated, which condition would greatly impair the quality of the finished product. In the last

compartment this is especially important since the sirup has become very heavy and burns easily.

The density to which the sirup is boiled has a great deal to do with its quality and selling price. If the sirup is made too thin it is liable to ferment and spoil, while if it is made too dense it will be in danger of crystallizing after standing for some time. It is usually considered that a maple sirup with a density of 60° to 65° Brix will give the best results under ordinary circumstances.

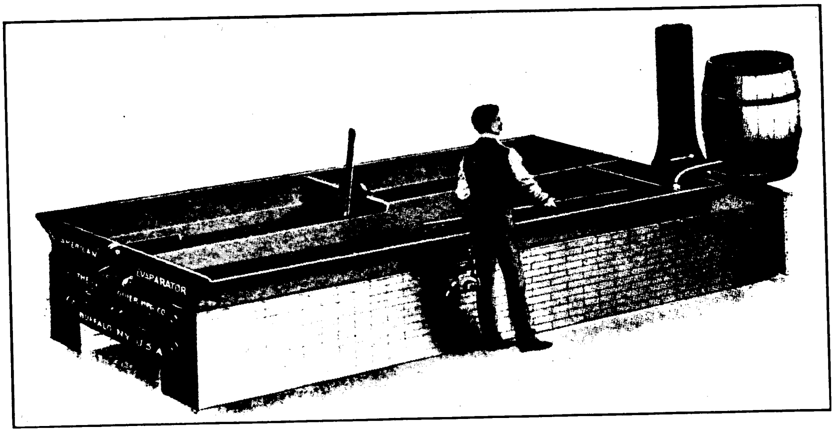
Many grades of maple sirup are on the market, all of which may be derived solely from the sap of the maple tree, yet each possesses such a distinct flavor as to lead one to conclude that some are artificial or adulterated sirups. The last sirup of the season and the sirup which has been burned during boiling, as well as those which have been made where strict cleanliness during the process was not practiced, have all an inferior flavor and color.

GLUCOSE SIRUP.

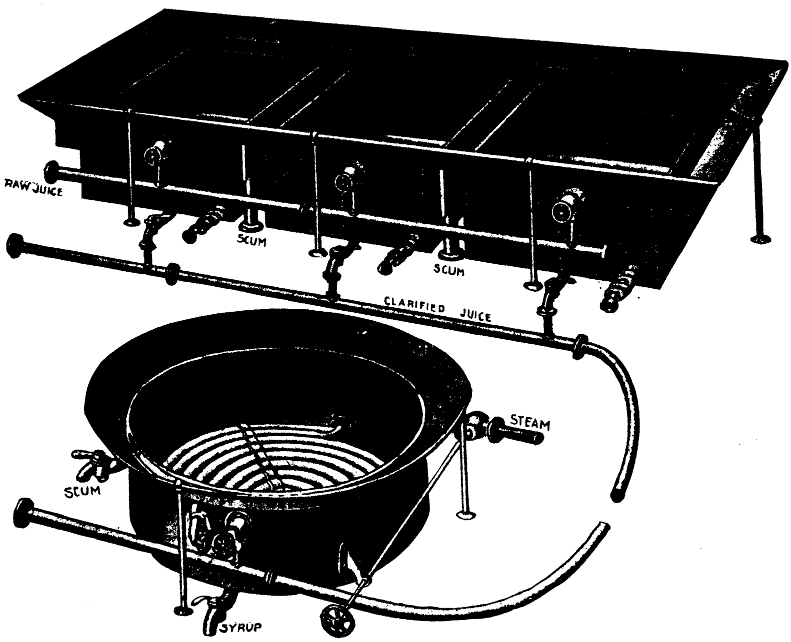
This sirup is sold under various trade names and in America is quite often called "corn sirup." The main reason for its receiving this name is that the starch from corn is extensively used in its manufacture. In Europe the starch from potatoes and rice is also used for this purpose. There is no essential difference in the sirup made from these starches, except in the details of manufacture. The principle used in the making of this sirup is to boil the starch with a powerful acid, such as sulphuric or hydrochloric, which exerts a hydrolytic effect upon the starch, splitting it up into its component parts and thus producing commercial glucose. This glucose includes several of the monose sugars and must not be confused with the chemical substance known as glucose or "dextrose" which is but one of the constituents of commercial glucose.

The amount of acid employed in the hydrolyzation of the starch depends upon the percentage of starch and impurities present. Usually, however, it will require from 1 to 3 per cent of a strong mineral acid. In recent years hydrochloric acid has been used extensively for this purpose since the precipitate which forms after the use of sulphuric acid, as formerly employed, gives the sirup a cloudy appearance unless it is entirely removed.

With many persons there is a prejudice against the glucose sirups because of the fact that glucose is an artificial or prepared



(*a*) Open-fire sirup evaporator.



(*b*) Steam-coil sirup evaporator.

This apparatus is provided with copper coils to carry the steam for heating and is arranged with a trough around the top to receive the brushings or light material rising to the top during evaporation.

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compound and is largely used as an adulterant in preserves and other delicacies for the more expensive sugar sucrose. If these sirups have been properly made and no foreign matter admitted, there is no particular reason for the existence of this prejudice on the ground of their being less wholesome than other sirups.

Sucrose or cane sugar in the course of digestion is first inverted or changed into the two components of ordinary glucose. These sugars are not as sweet as sucrose and they are therefore often mixed with a more powerful substance such as sucrose and saccharine in the preparation of sirups, preserves, etc.

The ratio of the sweetness of glucose (dextrose) to sucrose is usually considered as 2 to 3. That is, it is only about two-thirds as sweet as the cane sugar. Glucose sirup itself is a clear, colorless, fluent liquid. Its density is of course determined by the amount of solids present. While it has not an unpleasant taste, at the same time it would not appeal to the palate unless given some artificial flavor. For this reason, each factory making this class of sirups usually turns out a sirup with a peculiar flavor calculated to enhance its popularity. It is often customary, although not essential, to give the sirup a unique tint or color as well.

CONCLUSION.

There are large quantities of various kinds of sirups and artificial honeys shipped into these Islands each year, all of which could be readily made from homegrown products. Cane sirups, equal to or even superior to those found in most parts of the world, could be made from the Philippine sugar cane. The high purity of the original juice makes it especially adaptable to that purpose. If glucose sirups and artificial honeys are demanded, they can be made by a combination of sucrose from the sugar cane and the hydrolyzed starch or glucose from the rice and various other plants produced in these Islands.

The sap from certain sacchariferous palms indigenous to various parts of these Islands not only contains a high percentage of sucrose but also possesses a distinctive flavor which is quite pleasant. Among these plants may be mentioned the sugar palm (*Arenga saccharifera*). If it is desired to reduce or alter the flavor of these sirups or prevent them from crystallizing upon standing, this may be done by the addition of a quantity of glucose sirup made from the starch of the same tree.

In the preparation of any article for the trade it is necessary

to have a uniform product and put it up in attractive packages. It should always have a uniform body, color, and flavor. The containers should be thoroughly sterilized and the sirup should be poured in and sealed while it is hot.

With the classes of sirups which the Philippines are able to produce and with a proper selling agency to handle such products, there is no reason why they could not become of considerable commercial importance.

CITRUS BARKROT.

By G. H. ZERBST, *Station Superintendent.*

Citrus growing in the Province of Batangas has suffered a serious setback by the appearance of a disease known as barkrot, which, becoming particularly severe after the eruption of Taal Volcano in January, 1911, has led many growers to believe that the eruption which defoliated the trees is responsible for the outbreak.

The disease occurs not only in the towns of Tanauan and Santo Tomás which are near the volcano, but over practically the entire province. Tanauan and Santo Tomás, where citrus growing is the principal vocation of the people, have suffered heavily, and, unless checked, the disease threatens to wipe out the citrus groves of these towns.

The mandarin (*Citrus nobilis* Lour) appears extremely susceptible to the disease, which apparently has much in common with the well-known "gummosis," with the exception that the disease is an exudation of sap instead of gum. The calamondin (*Citrus mitis* Blanco) is also attacked, but with much less severity. The calamondin seems to be much more susceptible to the true gummosis.

The sweet orange (*Citrus aurantium* L.) and pomelo (*Citrus decumana* L.) are much more resistant than the mandarin, being seldom attacked to a serious degree.

One fact that distinguishes this disease from gummosis is that, while young trees and seedlings are susceptible to gummosis and are frequently attacked, even in the nursery, young trees are immune to barkrot.

A characteristic of barkrot, and in this it is similar to gummosis, is that in some cases badly infected trees mature their fruit prematurely, the fruit showing a bright yellow color while still very small. This is particularly noticeable in the mandarin as this fruit usually does not color well in the Philippines.

The disease makes its presence known by the oozing out of sap from the bark which softens and forms a putrid sore. These sores vary in size from one-half to 3½ centimeters in

diameter, and appear on the trunk and branches usually one-half to 1½ meters from the ground, although the disease occurs as high as 3 to 4 meters on the larger branches. Where the disease is severe these spots occur thickly and finally unite, with the result that the tree or branch is quickly and effectively girdled. Numbers of insects are attracted to the sores by the putrid sap, and the spots are usually found to be infested with the larvæ of various insects which aggravate and keep up the irritation, preventing the healing of the wound. As the tree strives to overcome the disease, the spots dry up, the edges of the sores begin to heal over, and the bark curls or scales, giving the branch or trunk an unsightly appearance. On brushing off the dead bark, the new wood is seen forming on the edges of the sores, giving to badly affected branches a queer distorted appearance.

The term barkot is to a certain extent misleading as the disease does not originate in the bark. If the bark and cambium layer are cut away and the underlying wood carefully examined, a dark-colored area, usually of a brown to reddish tinge, is found. This extends into the wood, varying in depth in different cases. As in gummosis, the sap collects in pockets between the wood and cambium layer until the bark is separated from the wood and finally split by the pressure within, so that the sap oozes out.

The Bureau of Science has carried on investigations with barkrot but has failed to find a bacterium to which the disease might be attributed.

Gummosis is, by various writers, attributed to excessively deep setting of trees when planted, or to the accumulation of earth about the trunk of the tree by cultivation. Barkrot, however, makes its appearance on trees whose crown roots are totally exposed.

Barkrot is not a disease that can be quickly cured by drastic measures, but one that necessitates the most persistent and intelligently directed efforts. To simply cut out the diseased area is useless, because the causal factors still remain. The removal of the effect without the elimination of the cause is a waste of time and money.

Apparently barkrot is a physiological disease produced by unfavorable soil and cultural conditions, and this is strikingly proven by the comparison of neglected groves with those that receive proper care and attention. Lack of cultivation is one of the main causal factors of other disease. In groves that receive no cultivation, the ground becomes hard and packed, and

in groves where cattle are also allowed to range, the earth speedily becomes nearly as hard as a cement floor. This packing of the soil prevents drainage and aeration, a condition that, needless to say, is fatal to citrus trees. Irregularity of the water supply is also a factor, and this can be controlled by proper culture and mulching.

Proper plowing and cultivation, varying in depth each year, and the planting of leguminous cover crops during the rainy season, are apparently essential in the prevention and cure of barkrot. The cover crop should be cut and left as a mulch during the dry season.

The treatment of the tree itself is a matter of secondary importance. The earth around the trees should be thoroughly loosened and stirred with a pick or mattock. The diseased spots should be carefully cut out with a sharp knife, and in doing this the cut should be made down to the healthy wood. The wounds should at once be painted with some protective material such as white lead paint; some writers recommend a mixture of wax, resin and oil.

The work being carried on by the Bureau of Agriculture along the above lines has proven satisfactory and the decided improvement of infected groves, under the treatment given, leaves little to be desired.

"DAPOG" METHOD OF RICE CULTURE.

By SILVERIO APOSTOL, *Agricultural Inspector.*

The custom of growing two crops of rice per year has been practiced for a long time in those parts of the Philippines where sufficient irrigation water is available the year round. In certain sections of the Provinces of Tarlac, Pampanga and Laguna, for instance, preparations for a second or dry-season planting are made shortly after the first or regular-season crop is harvested. Naturally the earliest of the lowland or irrigated rices are used for this purpose for two apparent reasons: first, in order to be able to gather the harvest before the rainy season has well started, and second, to allow ample time to prepare the land for the main crop.

Direct culture, in which the seed is sown broadcast by hand on the permanent field after the soil has been puddled and leveled, is the only method employed in growing the second crop in all these places except the municipality of Calauan and a small part of Bay, Laguna. In these latter localities the crop is started and transplanted by means of a method of seed bedding or growing the seedlings locally known as "dapog."

The dapog system enables the seedlings to be transplanted at a younger age than those grown in the ordinary way of seed bedding, without breaking the young plants when removing them from the seed bed. Earliness is of primary consideration in the dry-season crop, so that transplanting *young* seedlings is an essential condition sought for in the dapog method, as the age of the seedlings directly affects the maturing period of the rice crop. The older the seedlings are when transplanted, the later will the crop mature. In this connection it might be stated that the writer has observed from actual experiments a difference of as many as 23 days in maturing, between crops planted with dapog and with ordinary seedlings.

The preliminary preparation of the seed beds under the dapog system begins with that of the permanent field, as in this system the seed beds do not require any special ground. In the absence of rain, the field is irrigated, drained of excessive surface water, and then plowed and harrowed or otherwise prepared as for

a regular-season crop. When the ground is fairly well worked up, a plot near the irrigation ditch is further harrowed and then leveled for the seed bed. Proximity to the irrigation or inlet ditch is a necessary requirement because the water is not likely to become so hot there as elsewhere at midday and to scald or otherwise seriously affect the germinating seeds.

It takes from 15 to 30 liters more seed to plant one hectare by the dapog than by the ordinary method. The seed, placed in a burlap sack or similar receptacle, is first soaked in water (preferably slow running) for a period of 24 to 36 hours, and then removed and laid aside in the shade. At the end of another 36 hours, or when at least 75 per cent of the grains have shown signs of germination, the seed is sown on a seed bed prepared as follows:

That part of the paddy where the seedlings are to be grown is, as mentioned above, further harrowed on the same day that the seed is sown, and once leveled and the mud settled, the surface water is drawn off. Fresh, unbroken banana leaves, squared at the ends and cut lengthwise through the midrib are then laid flat on the thick mud so as to form beds about one meter wide and nearly as long as the width of the paddy. These leaves are placed with their peripheral edges toward the center of the bed, the split midribs thus forming a raised outer border. The ends of the long narrow beds so formed are closed with similar split leaves placed crosswise. The rounded extremities of the leaves used are cut off to facilitate fitting. Since one banana leaf split will rarely cover a meter in width, the two sections are drawn apart so that the split midribs will be flush with the edges of the bed and the peripheral edges will not meet in the center; the intervening space left in the center of the bed is covered with plain leaves from which the midribs have been completely removed so as to leave no ground exposed. If the leaf strips are badly torn, these tears should be covered with loose pieces of leaves. In fact, it is better to cover the entire bed with two or three thicknesses of leaves.

With the banana-leaf mat properly laid the bed is completed by covering it with a layer of either clean rice chaff or finely chopped rice straw to a depth of two or two and a half centimeters. A thick sowing of the sprouted seed is then carefully made on this surface. Seventy-five liters of seed are sufficient for seeding two dapog beds, each measuring fifteen meters in length and one meter in width. It is better to sow the seed in the afternoon and it should then be carefully and thoroughly sprinkled with the muddy water from around the beds.

In those months when the rays of the sun are intense, especially between ten o'oclock in the morning and two or three in the afternoon, it is generally necessary to build a light screen about 30 or 40 centimeters above the beds so as to protect the growing seedlings from the excessive heat. This screen can be made of banana leaves placed on a light frame of bamboo sticks and slats. More necessary and more important than shade, however, is a proper supply of water, and much care and attention should be exercised in watering the seed beds, especially during the first few days after sowing. This watering should be done several times during the day, and regular garden sprinkling cans have been used to great advantage by the writer in connection with his own work. Later, when the young plants are no longer in danger of being washed away, they should be irrigated with slow-running water until transplanting time, as standing water during a hot day is apt to seriously affect the young seedlings. While care should always be exercised in watering so as not to submerge and drown the young plants, the seed bed should nevertheless not be allowed to run dry for any considerable length of time at any stage of the young plants' growth, or else the seedlings would be fatally injured, especially if there is no shade during the heated part of the day. The rice chaff or the finely chopped straw, whichever is used, is practically the only medium in which the plants so seeded can grow, as they are, of course, deprived of the soil moisture by the underlying mat of banana leaves which, in a sense, forms a "hard pan" which their tender roots can not penetrate.

The dapog method of seeding, therefore, makes it possible to transplant seedlings at a much younger age than the ordinary method without at all straining or breaking them when removing them from the seed bed. The heavy rate of seeding is necessary in order to give the young seedlings, growing on such a light and loose medium, a firmer stand. The banana-leaf mat underneath naturally makes the roots run laterally rather than downward, and thus the roots of the neighboring plants soon interweave, and the seedlings are kept in an erect position. The entire bed is thus a long, narrow, carpet-like sheet of young plants, which can be easily lifted and removed from the underlying banana leaves. At transplanting, the "carpet" or "mat" of seedlings is torn into strips of convenient size, hung across the arms and shoulders, and carried to the field. Small strips may also be loosely rolled up with the foliage inside and transported to more distant points. In this

case the rolls should be undone immediately upon arriving at destination. Here the strips are further torn into pieces about the size of a small plate and scattered over the paddies in the same manner as the bundles of ordinary seedlings. These small pieces are picked up by the transplanters as they proceed with their work, held flat on the palm of the left hand by the left thumb, and then a few of the young seedlings at a time are pulled off by the thumb and the first two fingers of the right hand and stuck into the mud to make the hills.

The final harrowing and puddling of the field is done on the same day as the transplanting, or part of it may be done the day before. The dapog seedlings are ready to be transplanted from ten to fourteen days after the seed was placed in water. It is the experience of the writer that when the young plants are in good condition and properly handled, transplanting at the rate of from three to four seedlings to the hill and at the usual distance of from fifteen to twenty centimeters is sufficient to insure an even stand and a maximum yield under ordinary circumstances. The average rate of transplanting in common practice is higher. If transplanted when more than twelve days old, the dapog seedlings are greatly weakened, owing to the heavy rate of seeding and the nature of the seed bed, and consequently a larger death rate occurs. The ground on which the seed bed is located is not materially affected, and, once the seedlings are all removed, the banana leaves can either be taken up or harrowed under, and the entire paddy planted. If the seedlings have for any reason grown very tall, the upper portion of the foliage should be trimmed off before they are transplanted.

Recommendations.—Ordinarily, irrigated or lowland rice gives a heavier yield when it is transplanted than when grown direct by broadcasting the seed, and the writer strongly recommends at least the trial of the "dapog" method by those who have not as yet done so, especially with their dry-season crop. A beginning can be made by planting a small portion of the field by the dapog method side by side with a broadcasted lot, letting the results speak for themselves. The system was tried by some farmers of Santa Rosa, Laguna, some years ago, and, despite the extra expense incurred in transplanting, it has been gaining favor among the rice growers of that municipality ever since its introduction, gradually taking the place of the broadcasting method. In Calauan and Bay the dapog is the only method practiced at present for short or dry season rice, in preference to broadcasting, which was abandoned some time ago. The

writer has had very encouraging results in his own work at Calauan with the dapog system. The principal drawbacks with broadcasting are the necessity of special care in leveling the paddies and in the subsequent irrigating of the germinating plants therein, the impossibility of sowing evenly by hand and the consequent waste of seed, the impracticability of weeding, and, as a whole, the more uncertain results that generally go with broadcasting under ordinary circumstances. The rate of sowing is usually heavy so as to allow for the probable failure of many plants to reach maturity; however, if, on account of favorable conditions, only a small percentage of the plants fail before heading time, the remaining plants and their heads are consequently abnormally undersized and defective, and these conditions are to a great extent at least overcome by the dapog system. In other words, conditions are under better control with the dapog than with the broadcasting method. Of course, one of the principal factors that will determine the profitableness of the dapog method is the amount and cost of the available labor supply in a given locality. At any rate, second or dry season growing, whether by the dapog or by the broadcasting method, should never be attempted unless there is sufficient irrigation water available whenever needed during the growth of the crop. The dapog system can also be practiced in growing early lowland-rice varieties during the regular season.

NEW OR NOTEWORTHY TROPICAL FRUITS IN THE PHILIPPINES.[1]

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

When there are taken into consideration the modern facilities for travel, the rapidly growing intercommunication between even the remote corners of the earth and the rapid exchange of news through periodicals or correspondence from all parts of the world that characterize modern life, the temptation is frequently great to think that the localization of useful economics would almost be a thing of the past, and that food plants especially would soon be distributed to all parts of the world where the climatic conditions are favorable for their development. Yet, when the multitude of useful plants is considered as well as the extent of the geographical area in which they are or might be cultivated, and how comparatively few plants there really are that may justly lay claim to be truly cosmopolitan, one realizes how much plant introduction and distribution work there still remains to be accomplished. This refers in a peculiar degree to tropical fruits and particularly to those of the Philippines.

Every one conversant with the subject is well aware that some fruits are scarcely known outside of the countries to which they are native and the cultivation of still others can hardly be said to have begun even in those countries where they are indigenous.

This limited distribution is largely due to the non-keeping quality of the seed of so many tropical fruits, but with the rapidly expanding intercommunication and quick transportation between all parts of the world, and a better knowledge of the packing of seeds and plants so as to insure their safe arrival at the point of destination, there should soon be little if any excuse left for any part of the globe that does not grow those useful plants to which it is heir by reason of climatic adaptation. In the following paragraphs attention is called to a few species of fruit trees that are comparatively little known in the West-

[1] For other papers of a similar nature consult this REVIEW, Vol. V (1912), No. 11, p. 593, and Vol. VI (1913), No. 10, p. 493.

ern Hemisphere, and to others which are apparently new to horticulture or not well known even in the Far East outside of the Philippines:

BIGNAY, *Antidesma bunius* Spreng. EUPHORBIACEÆ. (Plate VI, *a.*) An attractive, diœcious tree, attaining a height of 4 to 10 meters; leaves alternate, 10 to 20 centimeters long, oblong ovate to elliptic or obovate, acute, or shortly acuminate, entire, shining; flowers small and inconspicuous, produced in axillary or terminal racemes—the male being reddish, and the female green—exhaling a pungent odor; fruits growing 20 to 25 or more on a raceme; individual fruit rather small, averaging 3 grams in weight, and 8 to 10 millimeters in length, spherical to ovoid, dark red; flesh juicy and pleasantly flavored.

Eighty per cent of the fruit is edible and the acidity 2.78 per cent.[2]

The fruit makes an attractively colored, red jelly, but this, in the several experiences of the writer, unfortunately has a very unpleasant aftertaste. If by some simple expedient this can be removed, the bignay would be excellent for preserves.

The bignay is of vigorous growth and very productive, with the main fruiting season in July and August. The tree is indigenous to Malaysia and is common in the Philippines.

CATMON, *Dillenia Philippinensis* Rolfe. DILLENIACEÆ. (Plate VII, *a.*) An ornamental tree, 6 to 15 meters tall; leaves dark green, 12 to 25 centimeters long, ovate to elliptic, or oblong ovate, coarsely serrate; flowers terminal, large and attractive, white, occasionally exceeding 12 centimeters in diameter; fruit averaging 60 to 65 grams in weight, 46 millimeters in length and 57 millimeters in width, globose to oblate, smooth; the persistent sepals grow large and somewhat fleshy, enclosing the fleshy, edible carpels, which wind spirally around the center of the fruit; flesh greenish, quite juicy and acid and containing a few small seeds or none at all.

Thirty-eight per cent of the fruit is edible; the protein content is 0.25 of 1 per cent and the acidity 1.52 per cent.

The fruit is too sour to eat out of hand, but makes an excellent sauce and would probably make a good jelly.

The catmon is indigenous and common throughout most provinces of the Philippines, but is seldom cultivated and is hardly ever seen abroad, even in botanical gardens. It makes a very good shade tree and endures close trimming of the crown better than most tropical shade trees. The fruit of the catmon as well as of the kambog, *Dillenia speciosa,* is greatly superior to that of the better-known *Dillenia indica.*

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[2] The analytical data in this article, except where otherwise stated, have been obtained from "Philippine Fruits: Their Composition and Characteristics" by D. S. Pratt and J. I. del Rosario, Philippine Journal of Science, Vol. VIII (1913), Sec. A, No. 1.

LANZONE, *Lansium domesticum* Jack. MELIACEÆ. (Plates VI, *b*, IX, *a*. See also this REVIEW, Vol. V (1912), No. 11, Plate II.) A handsome, symmetrical tree, attaining a height of 4 to 10 meters; leaves alternate, pinnate, 20 to 40 centimeters long, leaflets 5 to 7, oblong, acuminate, 8 to 18 centimeters long; flowers small, and borne on spikes from the trunk and larger branches; fruits growing 20 to 30, in grapelike bunches each weighing 375 to 450 grams; individual fruits comparatively small, being 30 to 40 millimeters long, 24 to 30 millimeters in equatorial diameter and averaging 17 grams in weight; form broadly ellipsoid to oblong ovoid; surface velvety; color dull straw; skin rather thick, tough, separating readily from the flesh; edible portion consists of 5 locules, separable from each other by a thin membrane; flesh whitish or translucent, tender, juicy, sweet, subacid, well flavored and of good quality; seeds 1 to 3, rather large, not infrequently absent, adhering to flesh.

Seventy-seven per cent of the fruit is edible, containing 1.13 per cent protein, 4.9 per cent sugar and 1 per cent acid.

The ripening season of the lanzone varies, in different localities, from August to late in November and even later. The writer has seen trees in bloom in the middle of August, in the interior of Mindanao, at an elevation of 810 meters, and sampled ripe fruit 4 days later in Zamboanga, at sea level.

The lanzone is of vigorous growth and succeeds best under somewhat the same climatic conditions as the mangosteen. It will not grow where there is a pronounced and prolonged dry season, and in the Philippines it is usually grown in half shade interplanted with the coconut.

The lanzone is extensively grown for the Manila market in Laguna Province, east of Santa Cruz, and is also cultivated to a considerable extent in Misamis, Zamboanga, the Sulu Archipelago, and around Argao in Cebu. In certain towns of Bukidnon and around Lake Lanao in Mindanao the lanzone is quite largely grown, but the fruit there is inferior to that produced at sea level, and it is evidently essentially a lowland fruit.

The lanzone is indigenous to Malaysia, and has barely been introduced beyond the Eastern Hemisphere.

LIPOTI, *Eugenia curranii* Robinson. MYRTACEÆ. (Plate VI, *c*.) A tree attaining a height of 9 meters or more, with gnarled trunk and tortuous branches; young growth quadrangulate, alate; leaves opposite, almost sessile, oblong-obovate, auriculate, acuminate, entire, leathery, dark green and shining; fruits congregated, 20 to 50 or more, in clusters on the bare branches or between the leaves on the more mature twigs; individual fruit small, averaging 3.35 grams in weight, globose, with cavity 3 millimeters deep; surface smooth, dark red, changing to black at full maturity; skin very thin; flesh red near skin, otherwise white, rather dry and crisp, pronouncedly acid with a pleasant flavor not unlike that of the crab apple; seed relatively large, clinging to flesh, sometimes absent.

The lipoti is too acid for a dessert fruit, but like its near relative, the duhat, *Eugenia jambolana* Lam., it would, in all probability, make an excellent jelly.

The lipoti is of vigorous growth, succeeds well where the wet and the dry seasons are strongly accentuated, and requires well-drained land for the best results. In productiveness it is exceeded by no other species in the genus that has come to the notice of the writer and ripens principally from April to June.

The municipal president of Bacon, Sorsogon, states in a letter to the Bureau that there are two varieties of lipoti ("Igot" or "Baligang," as the species is called in that province), black and white, and that the seedlings bear fruit 3 to 4 years from seed. According to him, the fruit is used in that locality for making preserves, wine and pickles.

Botanically as well as horticulturally the lipoti is a new fruit and is also in all probability indigenous to the Philippines. It was first collected by the writer in April, 1911, under the name of "Igot" in Catbalogan, Samar, and was described and named by the late C. B. Robinson, economic botanist, Bureau of Science, the following year. Fruits of the lipoti have been received by the Bureau from Laguna, Samar, Sorsogon and La Union, and it probably occurs in several other provinces. It is seldom cultivated.

The fruits illustrated on Plate VI, *c* were presented by Mr. José Rivera of this Bureau.

MABOLO, *Diospyros discolor* Wild. EBENACEÆ. (Plate VII, *b*.) A medium-sized tree, 8 to 15 meters high; leaves oblong, acute or abruptly acuminate, 10 to 25 centimeters long, entire, smooth and shining above and pubescent beneath; flowers axillary, small; the fruit measures 65 to 75 millimeters in longitudinal and 80 to 90 millimeters in transverse diameter, and averages 375 grams in weight, of which 73 per cent is edible, form roundish oblate with stem inserted in a conspicuous cavity; calyx persistent; surface smooth, velvety; color dull reddish; skin thin, adhering to flesh; flesh whitish, firm, rather dry, sweet, rather astringent, with a strong aromatic, cheesy odor that in a fruit is rather discouraging to the average European; flavor rather indefinite; seeds quite large, usually 4 to 8, adhering to flesh.

The mabolo analyzes 0.75 of 1 per cent protein, 6.9 per cent sugar, and 0.16 of 1 per cent acid.

There is also a variety (rarer than the red) with yellowish to light-brown fruits, the flesh of which is cream colored and sweeter, and less astringent. Trees bearing regular crops of seedless fruits are known in the Philippines.

The main season of the mabolo extends from June to September, but scattered fruits are found at practically all seasons of

the year. It is of medium vigorous growth and makes a desirable ornamental shade tree. It is indigenous to the Philippines and is fairly well introduced throughout the eastern Tropics. In the Western Hemisphere it is rarely found outside of botanical gardens.

The mabolo is a favorite with the native inhabitants, but hardly ever eaten by the European. Its chief value would seem to be in possibly crossing it with the kaki, imparting the flavor of the kaki to the hybrid fruit, while the mabolo might impart adaptability to the Tropics.

MANGOSTEEN, *Garcinia mangostana* L. GUTTIFERÆ. (Plate VII, *c.*) A small tree, 6 to 7.5 meters tall; leaves opposite, 15 to 23 centimeters long and 9 to 13 centimeters broad, oblong elliptical to oblong ovate, abruptly acuminate, thick and leathery with prominent midrib; fruit comparatively small, weighing 75 to 100 grams, seldom exceeding the latter figure, and averaging 6 centimeters in diameter; form spherical to a trifle flattened; calyx large, persistent; surface smooth; color reddish or purplish; bloom bluish; edible portion of fruit contained in the hard, shell-like, 8-millimeters-thick pericarp, which is pinkish inside and separates perfectly from the flesh; edible part of the fruit consists of 6 snow-white segments, each containing a seed or undeveloped embryo, a fruit seldom having more than two seeds; pulp juicy and tender but not melting, subacid, exquisitely flavored and faintly aromatic; seed enveloped in weak fibers extending into the flesh.

Twenty-nine per cent of the fruit is edible, analysing 0.5 of 1 per cent protein, 4.2 per cent sugar, and 0.49 of 1 per cent acid.

No one will deny the excellent flavor and quality of the mangosteen, but it is safe to say that its elevation by some old travelers to a par with the pineapple and the cherimoya as one of the three best fruits in the world—together with its restricted localization, the difficulty of its propagation and introduction into foreign countries and extremely slow growth—has done much toward making it famous. It is questionable whether it is really on a par with a first-class pineapple, and it is believed that the great bulk of people would prefer a well-grown carabao mango, as grown in the Philippines, to a mangosteen.

The mangosteen is of slow growth, and succeeds best in rich, loamy, moist but well-drained land. An even, warm climate with constant humidity, and a fairly abundant rainfall evenly distributed throughout the year, are practically indispensable for the successful culture of the mangosteen, and this, together with its slow growth and the short viability of the seeds, is accountable for its slow dissemination from its native home.

For these climatic reasons the culture of the mangosteen is

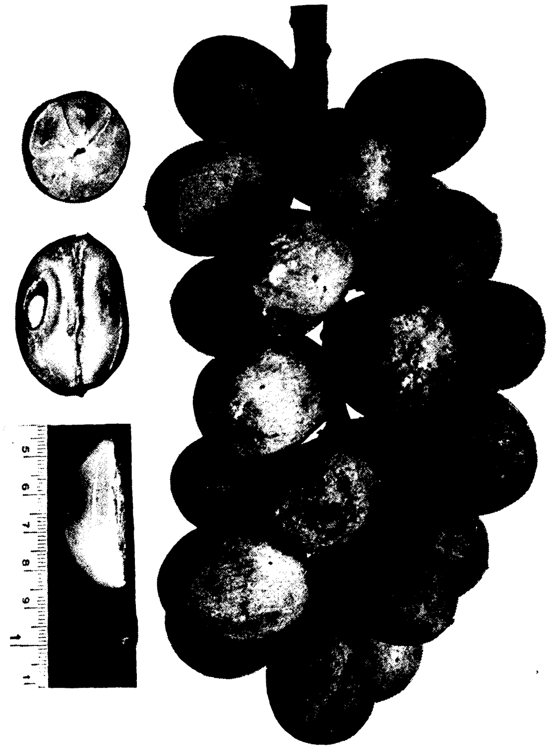
consequently probably excluded from the major part of the Tropics, and for the same reasons the area suitable for this fruit in the Philippines is rather restricted. Yet there is ample territory here where the mangosteen would succeed in supplying the home demand and leave a handsome surplus for export to Hongkong, China, and Japan. The lanzone district of Laguna and the protected valleys of Tayabas, Albay, Ambos Camarines, Sorsogon, northern Samar, Butuan and Davao are suggested as suitable for the mangosteen. At present the mangosteen is confined to the Sulu Archipelago, except perhaps two dozen trees on the north and west coast of Mindanao, some three or more trees in southern Negros and one in Porac, Pampanga. Nearly all the mangosteen trees in Mindanao are found in Dapitan, where they were introduced together with many other fruits by José Rizal during his banishment there under the Spanish régime. The 50-year-old tree in Dumaguete, Occidental Negros, and younger trees in Misamis and Oroquieta seen by the writer, are indubitable evidence that the mangosteen may be successfully grown in those localities. Yet the annual supply sold in Manila is mostly imported from Singapore and Saigon.

Among the better known trees perhaps no species has been so slow of dissemination as the mangosteen. It was already well known and described by Linné, yet 100 years elapsed before the first tree fruited in the American Tropics in Trinidad. A few trees have since fruited in Jamaica and Hawaii, and only last year did the first tree fruit in Queensland, Australia. This fruit has scarcely found its way beyond the botanical gardens except in the East.

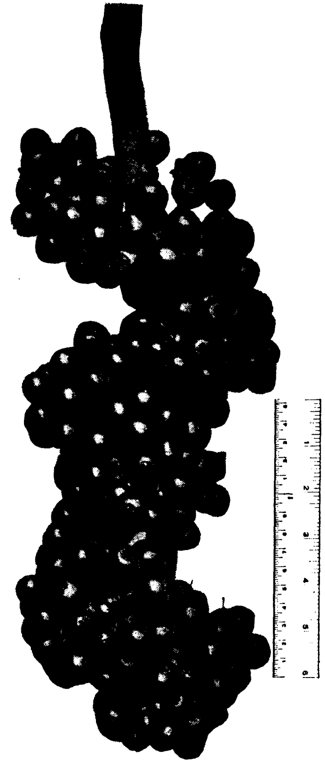
Mangosteen culture would no doubt be considerably furthered if a congenial, vigorous stock could be found, but the more substantial hope for the future is unquestionably the hybridization of the mangosteen with some of its numerous relatives.

MARANG, *Artocarpus odoratissima* Blanco. URTICACEÆ. (Plates VII, *d*, IX, *b*.) A tree of medium size, similar in habit to the bread fruit; leaves large, dark green, 45 to 60 centimeters long, and 25 to 30 centimeters broad, entire, or more or less trilobate; fruit very large, averaging 16 centimeters in length, and 13 centimeters in transverse diameter, and attaining a weight of 1,000 to sometimes exceeding 1,800 grams, roundish oblong, regular, thickly studded with soft, greenish yellow spines, about 7 millimeters long on the outside; rind thick and fleshy; flesh white, very sweet and rich, juicy, very aromatic and of excellent flavor, separated into segments (about the size of a grape) clinging to the core, each segment containing a seed; seeds many, whitish, 8 by 15 millimeters, smooth, separating readily from the flesh.

(*a*) Bignay (*Antidesma bunius*).



(*b*) Lanzone (*Lansium domesticum*).



(*c*) Lipoti (*Eugenia curranii*).

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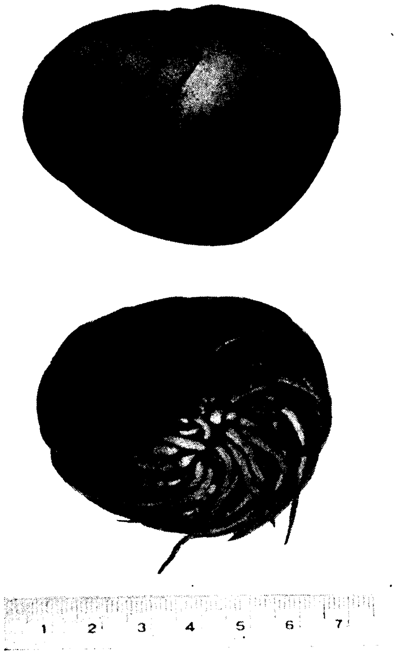
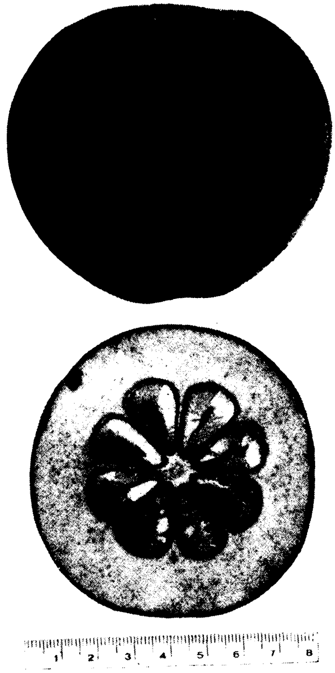
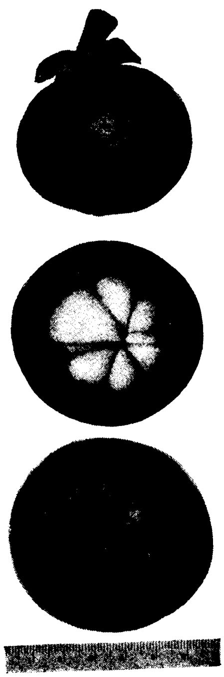
PLATE VII.



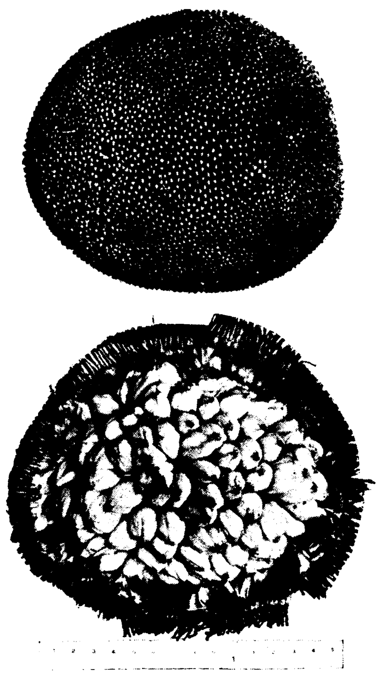
(*a*) Catmon (*Dillenia philippinensis*).



(*b*) Mabolo (*Diospyros discolor*).



(*c*) Mangosteen (*Garcinia mangostana*).



(*d*) Marang (*Artocarpus odoratissima*).

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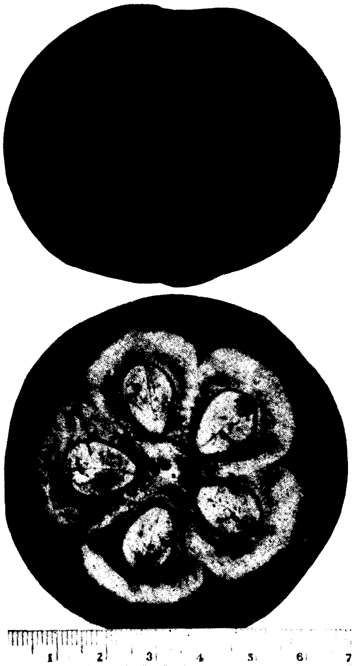
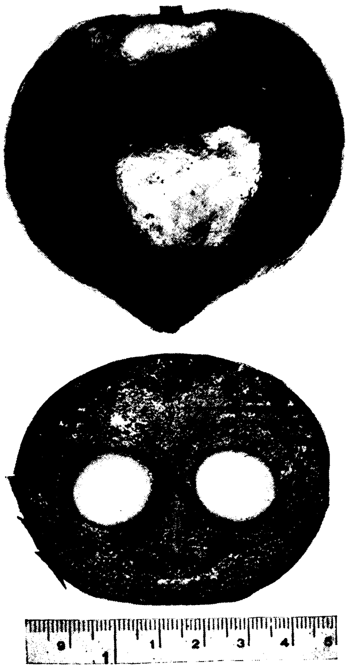
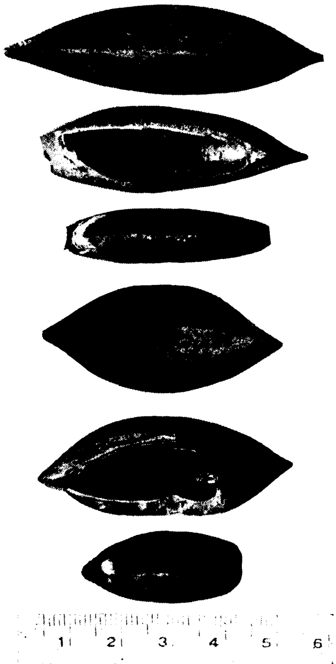
(*a*) Comihan (*Artocarpus elastica*).



(*b*) Santol (*Sandoricum koetjape*).



(*c*) Baniti (*Garcinia dulcis*).



(*d*) Pili nuts (*Canarium ovatum*).

The three topmost are the long type; the three lower the short, broad type.

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(*a*) Lanzone tree (*Lansium domesticum*).

(*b*) Marang tree (*Artocarpus odoratissima*).

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By passing a knife around and through the rind of the mature fruit, with a little care, the two halves of the rind separate from the flesh, leaving this adhering to the core not unlike a bunch of white grapes.

Of a fruit examined by the writer, weighing 1,080 grams, the rind weighed 615 grams, the core 130 grams, the seeds (100 in number) 85 grams, and the flesh 250 grams, the edible portion of the fruit being 24 per cent of the total weight.

The marang is very rich in carbohydrates and in flavor is not unlike the sugar apple, which, however, it greatly surpasses in richness. As a dessert fruit it is far superior to the jak and related species in the Philippines, and will undoubtedly attain prominence among the tropical fruits when it becomes better known.

July and August is the main season for the marang, which is found in the Sulu Archipelago, on the south coast of Mindanao from Zamboanga to Davao, in the interior of that island at Lake Lanao, and in the Islands of Basilan and Mindoro.

The marang thrives under climatic and soil conditions similar to those enjoyed by the mangosteen and the lanzone, and is usually grown in partial shelter, interplanted with taller trees such as the coconut. Considering how fond the Filipinos are of the marang it is most surprising that this fruit has not become more widely dispersed in the Archipelago.

GOMIHAN, *Artocarpus elastica* Reinw. URTICACEÆ. (Plate VIII, *a*.) A tree of medium size, sometimes exceeding a height of 15 meters, with the habit of the bread fruit; leaves 35 sometimes exceeding 50 centimeters in length and 32 centimeters in width, entire or with three or more large lobes, dark green, rather rough and hairy beneath; fruit spherical, 9 rarely exceeding 11 centimeters in diameter, orange-yellow, covered with threadlike, hairy, rather coarse, more or less twisted filaments 35 millimeters long, skin thick, separating readily from the flesh like the marang; flesh watery, white, sweet, juicy, somewhat aromatic and of fair to good quality; seeds many, small, separating readily from the flesh.

The gomihan is probably more closely related to the marang than any other species in the genus, and resembles it in structure, texture and flavor, though greatly inferior to the marang pomologically.

The gomihan has been noted in Ambos Camarines, Albay, Sorsogon, Tayabas, Samar, Masbate, Biliran, Surigao, Agusan and Mindoro and probably extends to most islands in the Philippines. The tree is rarely cultivated, and the fruit, ripening from May to July, is but little esteemed. The seeds, roasted and eaten like peanuts, are of fair quality.

The gomihan was first called to the attention of the writer by Mr. E. E. Schneider, Bureau of Forestry.

SANTOL, *Sandoricum koetjape* (Burm.) Merr. MELIACEÆ. (Plate VIII, *b.*) A medium sized tree attaining a height of 15 meters; young growth pubescent; leaves trifoliolate, leaflets 10 to 15 centimeters long, elliptic to oblong ovate, acuminate; flowers numerous, greenish yellow, in axillary panicles 10 to 20 centimeters long; the fruit averages 4 to 5 centimeters in length, 5 to 6 centimeters in equatorial diameter, and weighs 100 to in good varieties exceeding 150 grams; form roundish oblate to oblate; stem stout, inserted in a shallow cavity; surface velvety; color brownish yellow; rind 6 to 14 millimeters thick, tough and leathery; pulp in five sections, separable from the rind, whitish to translucent, rather fibrous (fiber fine), juicy, subacid, aromatic, in good varieties spicy, vinous and of excellent flavor; seeds 5, large, embedded in the pulp, clingstone.

The edible part analyzes 0.86 of 1 per cent protein, 3.08 per cent sugar, and 1.35 per cent acid.

Indigenous to Malaysia, the santol is one of the most widely distributed fruits in the Philippines. The tree is hardy, of vigorous and rapid growth, and succeeds well even where the dry season is prolonged. The fruit is produced in great abundance, in fact in such profusion that large quantities annually rot on the ground during the ripening season which extends principally from July to October. It should be stated that the waste of the fruit is due chiefly to its poor quality, in fact, from the European point of view most of the santols are barely edible. However, now and then trees are found whose fruit is of most excellent flavor, and when a fruit shall have been found that also has the feature of being seedless or semi-seedless like the mangosteen, it is believed that the now practically unknown santol will become one of the most popular of the tropical fruits. The santol can be utilized in making a jelly and marmalade of very distinct flavor and of excellent quality.

BANITI, *Garcinia dulcis* Kurz. GUTTIFERÆ. (Plate VIII, *c.*) An evergreen tree, 7.5 to 9 meters tall; leaves opposite, 15 to 24 centimeters long, 5.5 to 9 centimeters broad, oblong, undulate, thick and leathery; base acute; apex abruptly acuminate; flowers several in axillary clusters; fruit more or less irregular in outline, from sub-globose-turbinate to sometimes flattened, the shape depending largely upon the development of one or more seed embryos, 5.5 to 6.5 centimeters long, and 5 to 7 centimeters in transverse diameter, averaging 132 grams in weight; stem, with usually 5 persistent sepals, inserted in a shallow basal cavity; apex pointed; surface smooth; color lemon-yellow; skin very thin; flesh deep lemon-yellow, juicy, melting, very similar in texture to a good mango except in having even less fiber and being juicier; very acid; seeds usually 2, rarely exceeding 3, 34 millimeters long, resembling in appearance a large bean, clingstone.

The flesh constitutes 91.55 per cent and the seed 8.45 per cent of the fruit.

According to Dr. H. C. Brill, assistant chemist, Bureau of Science, the analysis of the pulp of the baniti is as follows:

Moisture		84.42
Insoluble solids	6.78	
Protein (N x 6.25)	0.82	
Invert Sugar	2.64	
Acidity (citric acid)	3.61	
Ash	1.73	
Total solids		15.58

A striking feature of the fruit of the baniti, considering that it is absolutely unimproved and is found only in its natural wild state, is the excellent texture of the flesh, the absence of fiber, and the exceptionally great proportion of edible pulp; furthermore, the flesh is attractively colored. The one great defect which in its present state of development precludes its use as a dessert fruit uncooked is its lack of sugar and its extreme acidity. Undoubtedly it would make an excellent preserve.

The baniti is found from northern Luzon to the Visayas, Mindanao and Palawan under varying climatic conditions, and is in fact one of the most widely distributed species of the genus in the Philippines.

So far as known the baniti has heretofore never been cultivated and is rare even in the botanical gardens of the eastern Tropics; its pomological possibilities seem hitherto to have been overlooked. The writer's attention was first called to the baniti by Mr. A. W. Prautch, of Manila, who submitted a number of well-known fruits, collected in Antipolo, Rizal; according to him sweet-fruit trees are found in the same province. As a matter of fact the specific name of the plant indicates that it was described and named from specimens of such a variety.

The tree is prolific and the fruit ripens from February to May.

The greater range of climatic adaptability and the robust character of the baniti suggest that, if the two species are sufficiently congenial, it might be valuable as a stock or for hybridization with the mangosteen.

PILI, *Canarium ovatum* Engl. BURSERACEÆ. (Plate VIII, *d.*) A rather large tree, 15 to 25 meters in height, of medium compact growth and rigid branches; leaves about 40 centimeters long, 7 to 13 pinnate, with pinnæ 10 or more centimeters long, rather thick, dark green, prominently veined; flowers in axillary panicles, greenish yellow, rather small and inconspicuous; fruits 1 to 4, ovate to oblong, 45 to 75 centimeters long, more or less triangular in cross section, black, smooth and shining, each containing a nut enclosed in a fleshy husk 325 millimeters thick. The nuts occur in two forms, short and long, and are more or less distinctly three-angled, frequently canaliculate, more or less sharply pointed at each end, brown

and smooth, the short form being from 45 to 60 millimeters long, and the slender form 55 to sometimes exceeding 70 millimeters in length; shell thick and hard; kernel oblong, separating readily from the shell, light, brittle, and of excellent quality raw or roasted.

One kilogram contains 130 nuts, of which the shell constitutes 81.71 per cent and the kernel 18.29 per cent in the short, and the shell 81.13 per cent and the kernel 18.87 per cent in the long kind. According to Dr. H. C. Brill the kernel in each kind gives the following analysis:

Composition of kernel.	Long.	Short.
	Per cent.	*Per cent.*
Moisture	2.79	2.9
Fat	74.37	72.53
Protein (N x 6.25)	12.06	11.88
Sucrose	.88	.66
Reducing sugars	.45	1.35
Starch (by difference)	4.33	5.11
Crude fiber	2.15	2.42
Ash	2.97	3.15

A glance at the above analysis shows the two kinds to be identical for all practical purposes. The fat, protein and sucrose, are somewhat greater in the long than in the short variety. Unfortunately the short kind is the one usually found in the market, the long variety constituting perhaps 5 to 7 per cent of the total bulk marketed.

The pili is found in southern Luzon, the Visayas and Mindanao in districts having abundant rainfall throughout the year.

Practically all the nuts on the market come from Sorsogon, Albay and Ambos Camarines. The nuts are gathered either in the forest or from trees that have grown spontaneously in the abacá or occasionally the coconut plantations. The pili is never planted and cultivated.

The pili is of very slow growth and while no accurate statistics are obtainable it seems probable that the tree does not produce an appreciable crop until it has attained an age of 10 years. At this age the average annual yield per tree is probably not more than 8 to 10 kilograms. The estimates of the average annual yield per tree from fullgrown trees as given by local growers vary from 30 to 1,000 kilograms, one grower stating that he has an exceptionally large and productive tree that has yielded 5,000 kilograms. An average yield of 100 to 150 kilograms of cleaned nuts is probably a conservative estimate; the yield may be considerably larger. It could undoubtedly be greatly increased by planting budded trees.

Before the nuts are marketed the fleshy husk is removed by

heaping the fruits in piles and covering them with leaves, or placing them in vats or barrels filled with water. The fermentation of the husks permits their ready removal from the nuts in the course of 2 or 3 days by washing in cold water.

During the last 2 years the nuts have been husked by boiling the fruits but this method results in the rapid deterioration of the kernel and renders the nut unsalable.

The boiled husks of the pili are also a common article of food in those localities where the tree grows. In texture and appearance this food resembles the sweet-potato but is tasteless and insipid; there are no data relative to its food value.

The one great defect of the pili is the thick, bony shell which resists any attempt at breaking with the ordinary nut cracker; the nut can not therefore be served on the table like other nuts. such as the almond, chestnut, etc. However, when a practicable method of vegetative propagation shall have been devised, so that selection can be begun among the tens of thousands of seedlings that are found in the pili regions, and "paper shell' pili varieties become established, we may expect a tremendous popular demand for this excellent nut and to see large pili plantations come into existence.

The seeds of another species, C. *luzonicum* Gray, are sometimes erroneously credited with furnishing pili nuts for the market. The nuts of this species are, however, quite distinct from the real pili, being much smaller and blunter at the ends. The nuts are of good quality, and the tree has the distinct advantage over the pili of succeeding on very poor and shallow soil where the dry season is long and pronounced, qualities that might make it a valuable stock for the pili and extend the cultivation of this nut far beyond its present area.

Many short-sighted people are inclined to regard fruits as more or less unnecessary luxuries, belittle their culture and consider their production rather unimportant. While rice, corn and certain root crops are willingly conceded to be the *piéces de résistance* of our population, probably most people are also willing to admit that without the addition of more savory dishes these would make a dry and monotonous diet. Fruits serve as appetizers, and supply several elements that stimulate digestion. Let us not forget that many fruits are rich in carbohydrates—fuel, so to speak—and some contain considerable protein.

There is always a ready market for good fruit and it is safe to state that no part of the Philippines is yet oversupplied in this respect. All sections would be decidedly better off economically and otherwise if more and better fruits were grown and

in greater variety. However, while the extension of a fruit into new territory is desirable, good judgment should be exercised in introducing fruits into a locality where they have not hitherto been cultivated or disappointment and financial loss may result. For instance, it would be folly to attempt the cultivation of the mangosteen or the lanzone in those regions which have a long, dry season, or to grow mangos in sections where the rainy season coincides with the flowering period of this tree; nor would it be advisable to plant citrus trees or pineapples on annually inundated or poorly drained land, or where the rain is insufficient, unless these exigencies were provided for. In other words, while the cultivation of a few fruit trees of various species is always to be encouraged, in fruit growing, considered as a business enterprise, the would-be fruit grower should limit himself to those species and varieties that experience has shown to be adapted to his local soil and climatic conditions.

CLINICAL OBSERVATIONS ON COCCIDIOSIS IN CATTLE AND CARABAOS.[1]

By C. H. SCHULTZ, M. D. V., D. V. M.[2]

During the latter part of 1912 and until May, 1913, my duties as assistant in the veterinary research laboratory at Alabang permitted careful observations of numerous cases of experimental rinderpest. The great number of "atypical cases" soon attracted my attention; these had been noted by many observers and were invariably classed and accepted as atypical cases of rinderpest. Rinderpest in the experimental animals was produced by the subcutaneous injection of virulent blood into nonimmunes.

In the middle of August, 1913, I was sent to look after the large number of work animals of the Calamba Sugar Estate at Canlubang, Laguna, where losses from obscure causes among cattle had been severe for some months previous.

Most of the horses and ponies on the estate had perished from surra, but the microscope failed to show the well-known trypanosomes in cattle or carabaos, although several hundred animals were subjected to the usual blood examinations.

Many of the work oxen were dying and a great number were in such a weak physical condition that they were unable to work. The causes of these repeated losses were obscure, and after a reasonably careful survey of the situation it appeared that the deaths and condition of the animals were due to different factors. A great number of the weak animals, however, suffered from irregular evacuations of the bowels; some had diarrhea, more or less severe, and others had what appeared to be "tropical dysentery." The latter were greatly emaciated and cachectic, although continuing to eat as long as they could. Their temperatures were invariably a degree or two above normal. Others, in somewhat better condition, showed as a common symptom an irregular, persistent diarrhea, with only occasional distinctly dysenteric evacuations. Of about fifty animals that were kept together, some were always neat and trim, fat, and able to do

[1] Paper presented before the Manila Medical Society, July 6, 1914.

[2] Formerly of the veterinary division, Bureau of Agriculture.

good work, and were never sick. Those that had been on the place several years appeared to do best. No particular type appeared to be immune, but the young animals were attacked in greater number than the old. Thirty work oxen had died during the month of August. In previous months the losses were, I was told, greater; various causes were ascribed, among others being poison weeds, gastritis due to excess of alkali in plants or water, and other equally obscure ailments.

As soon as possible the sick animals were segregated and divided into different groups, so as to facilitate the study, and, if possible, permit an identification, of the unknown disease.

On August 30 the presence of rinderpest as one of the causes was established. Clinical history, symptoms and post-mortem findings all sustained the diagnosis.

Simultaneous inoculations were begun on a lot of 35 animals on September 4. These were injected with 2 cubic centimeters of virulent blood brought from Alabang, receiving at the same time 100 cubic centimeters of anti-rinderpest serum. Eight of the oxen showed temperatures from 39° to 40° centigrade, when they were inoculated and one, No. 303, registered 41.5°. The animals had been worked hard until the evening before the injections, thus giving no opportunity to examine them clinically, except to take one evening and one morning temperature.

The results of these hasty simultaneous inoculations were, to me, most remarkable. Several of the weak, high-temperature animals died in a few days; some of the others, after four days, began to have a severe diarrhea, becoming dysenteric. Feces, at first dry, hard, and coated, soon showed large flakes of mucus, tinged with blood. This dysentery was of the same type as that observed in cases of experimental rinderpest during my stay at Alabang, where it was considered pathognomonic. As a result of the rinderpest-blood and antirinderpest-serum injections, some of the animals were depressed and suffered as if they had ingested corrosive poisons in dilute state. Others rallied after the first few days, but lost strength and drifted into a cachetic condition lasting weeks.

Diseases that produce acute dysenteric attacks of such a severe and persistent type in domestic animals are few, and, as in human beings, are invariably due to specific causes.

A few days before, while examining blood slides from carabaos for surra, slides of mucus from diarrheal feces were examined microscopically and numerous round or oval, more or less granular, transparent cysts, with a neat double contour, which were at first accepted as ova from intestinal parasites, were noted.

In the dysenteric feces very few of these could be found, but upon closing the diaphragm to the proper point, thousands of elliptical or irregularly oval, granular, transparent bodies, with vague outlines but showing a well-defined nucleus, were at once observed. These were the same as those observed on slides from the intestines of castrated bullock No. 235, which died on August 25. On August 26 similar bodies and rounded cysts were found in the feces of No. 92, an old animal that was greatly emaciated and afflicted with chronic diarrhea and occasional dysenteric attacks. The same organisms were found in a middle-aged animal, No. 74, which died August 27 after a lengthy attack of diarrhea. These oblong, more or less granular bodies were scarce, but other forms, irregularly club shaped, of indefinite outline, often presenting a well-defined nucleus, were present in great numbers.

Since these organisms were constantly found in immense numbers, and always associated with and usually in the mucus flakes, their relation to the dysenteric feces could not be denied.

On August 28 a group of 12 animals was confined in the Canlubang corral; in the feces of seven of these, the same organisms could be found in great numbers. On September 1 castrated bullock No. 37, which had a temperature of 40.4° (one degree less than its temperature of two days before), and was very weak and emaciated, was selected by Doctors Ward and Boynton as a clinical case of rinderpest and destroyed for post-mortem examination. I assisted at the autopsy. The lesions corresponded to those found in acute rinderpest, except that no ulcers were found in the bucal cavity. Blood taken from the cadaver and injected into a nonimmune experimental animal at the research laboratory at Alabang failed to reproduce the disease.

It was not until September 20, after making careful observations in the field and in the immunization corrals, and after due consideration of the notes taken at numerous post-mortem examinations, that I was able to establish the final diagnosis of acute or chronic coccidian gastro-enteritis.

Once the cause was known field observations became simplified. During August and September all work animals suffering from diarrhea or dysentery, as well as those that were cachectic, were sent to the Canlubang corral. Soon after the early reports to Mr. N. C. Campion, then in charge of the Calamba Sugar Estate, the question of clean drinking water for the animals was taken up, and it was due to his energetic efforts that watering troughs for the work cattle were put up in suitable places and kept filled with artesian water. The corrals were supplied with

pumps and troughs, so that even the weak animals could have free access to clean drinking water. This, together with the dividing of the large herds into small units and the feeding of a good allowance of cut forage, decreased the death rate and lessened the number of weak animals.

Forty-four cattle (34 of which were afflicted with the disease in question) which were kept in the Canlubang corral, looked after with reasonable care, fed regularly and supplied with clean creek water in a watering trough, made slow but steady recoveries. Feces from several of these animals, as well as from all those that died, were examined, invariably with the same results. Blood smears were always negative. On October 4 this herd was turned out to graze on nearby pasture. These animals had been checked up carefully and as far as possible, were well known to me. After they had been driven to grass for two weeks, many began to lose weight, looked depressed, and were languid; several became afflicted with excessive watery diarrhea but not dysentery. After losing flesh and strength, about one-third of these animals become anemic, cachectic and greatly emaciated, and died from coccidian enteritis. Some of them rallied and made a good recovery, but many remained chronic invalids.

It is typical of protozoan diseases that the contagion exists outside the body in insects (as in malaria or Texas fever), or in water pools or on swampy ground (as in coccidiosis), and since the virulency of subsequent attacks depends upon the amount of virulent material ingested, these cases were not relapses, but were due to reinfections. This conclusion enabled me to lay the blame on infected swampy pastures or waterholes.

When we attempt to solve a problem with one or more unknown quantities, it is necessary to compare these unknown with known values. Fortunately I was able to compare the disease that was so extensive, obscure and so difficult to distinguish from rinderpest, with other diseases due to coccidia.

In 1902, while in the United States Meat Inspection Service at Tacoma, Washington, a peculiar condition in the liver of lambs attracted my attention; the microscope demonstrated as the cause a sporozoön (coccidium); tissue was forwarded to the Bureau of Animal Industry at Washington, D. C., where my diagnosis was confirmed.

Again in 1906, while in general practice in Tacoma, Washington, a great mortality among Belgian hares was identified as coccidian enteritis, due to *Coccidium oviforme* (not *C. perforans*).

The literature on coccidiosis in cattle has until the last few

years been very scanty. The earliest publications appeared in the "Schweizer Archiv für Tierheilkunde," Volume XXXIV, 1892, from the pen of Doctor Zschokké (1) (Zurich) and Doctor Hess (2) (Berne). In 1893 an article by Doctor Guillebeau (3) (Berne) on *Coccidium oviforme,* causing red dysentery in cattle, was published in Berne. All the textbooks on veterinary medicine and therapeutics as well as on protozoan parasitology refer to these articles.

During the time that I was making observations in this herd in the Canlubang corral, three different lots of cattle were subjected to simultaneous inoculation against rinderpest. The first lot, containing, as stated, 35 animals, was inoculated on September 4; the second lot of 30 was inoculated on September 18; and the third lot of 30 on September 30. The usual method of injecting 5 cubic centimeters of virulent blood, from an animal in the early febrile stage of rinderpest, simultaneously with about 300 cubic centimeters of anti-rinderpest serum, was adopted. All the animals that, as a result of these subcutaneous injections, showed fever, and sooner or later diarrhea or dysentery, had present in their evacuations blood-tinged mucus flakes, characteristic of coccidian dysentery; clinically they presented no difference from the acute type of field cases which were studied at the beginning of the outbreak and which had to be accepted as acute coccidian enteritis.

Material for clinical observations was most abundant, and on account of the great mortality, the clinical history of several cases could usually be supported by post-mortem examinations.

Observations were made on more than 120 field cases and 95 animals that were subjected to simultaneous inoculations. Of these, 35 animals were checked up in a systematic manner. Post-mortem examinations were made and notes were taken in 32 cases of coccidian enteritis.

Many of the animals that were subjected to simultaneous inoculations made slow and unsatisfactory recoveries; they became anemic, cachectic, and suffered from chronic diarrhea, which would at times assume a more or less dysenteric type; several died and many remained so weak that they were useless as work animals.

The observations on all these inoculation cases of rinderpest corresponded in every particular with the acute or chronic type of field cases, where the diagnosis of coccidian gastro-enteritis was arrived at after careful consideration of history, symptoms, post-mortem reports, microscopic examinations and due consideration of available literature.

In the latter part of October, after having spent two months on this estate, orders from the central office assigned me to duty elsewhere, and I have since been able to make only one short observation trip to Calamba (November 5, 1913). The next opportunity that permitted study and verification of the observations taken in the field came in February, 1914, when I was requested to carry out experiments with the cultivation of rinderpest virus in vitro. Part of the immunization sheds at the Pandacan quarantine station were reserved to accommodate the experimental animals, while the cultures were kept in incubators and the laboratory work was done, by permission of Dr. Alvin J. Cox, Director, and Dr. E. L. Walker, Chief of the Biological Division, in the laboratories of that division of the Bureau of Science.

All the animal inoculations or cultures were begun with virulent blood obtained from cases of experimental rinderpest as they have been studied and as they occur at the veterinary research laboratory at Alabang.

Two types of animals were used in these experiments: a larger, coarse breed from Dalupiri, all males, and smaller, neater, nervous animals, all females, from the Island of Fuga. From observations made at Alabang, it was known that the Dalupiri animals were more susceptible to one type of disease, and the smaller Fuga cattle to another. This phase of the experiments, if definite observations could be made, would divide the sick animals into two classes.

The first two animals were inoculated on February 9 with 5 cubic centimeters and 2 cubic centimeters, respectively, of citrated rinderpest blood obtained from Alabang. Both animals, Fuga female No. 3717 and the Dalupiri male No. 3696, died on the 10th and 12th day, respectively, after the inoculation; the diagnosis was confirmed by lesions found at autopsy.

Blood from these two animals was obtained and mixed on February 17, when the disease was clinically identified as rinderpest, and Fuga female No. 3706 and Dalupiri male No. 3690 were each injected with 10 cubic centimeters of this citrated virulent blood. The Fuga cow succumbed to a clinically not well-marked attack of rinderpest with only moderate temperature reactions. Autopsy, however, showed marked lesions of rinderpest.

In the Dalupiri male (3690), a strong vigorous animal, the disease developed into a well-marked, typical case of acute rinderpest; the highest temperature (41° C.) was observed on the fifth day; the period of high temperatures was from the

fourth to the eighth day; the attack was of long duration and the animal made a slow recovery, without relapse. Diarrhea began on the 7th day, and on the 8th day the evacuations became offensive, a great deal of mucus being passed. This severe diarrhea, often dysenteric, persisted more or less for 20 days, when feces began to assume normal form and the animal began to show rapid improvement. On the 15th day a dry, scaly skin eruption, extending over neck, shoulders and back, made its appearance. The type of diarrhea of this animal, and the symptoms as they were produced during the course of this disease, were identical with those of an acute, severe attack of coccidiosis, although it was caused by the injection of 10 cubic centimeters of citrated virulent blood from clinically identified rinderpest cases, showing at subsequent autopsy well-marked typical lesions.

The animal was turned out to pasture on March 17. Since then it has done well, but passes coccidia in feces. On March 28 it was reinjected with 10 cubic centimeters of rinderpest blood; it was immune, no reaction being produced.

With No. 3690, which was a clinically typical case of rinderpest with great loss of flesh, marked offensive diarrhea and dysentery, and which made a slow but steady recovery, we must compare some of the atypical cases, especially those that result in death in a few days and show constipation instead of diarrhea.

Animals that become afflicted in a pronounced manner, where the clinical symptoms are marked and readily permit a correct diagnosis, present no difficulty. Only few of the reactors showed definite symptoms. In many the reaction was unusually obscure.

The post-mortem notes taken during my stay at Calamba had shown that the cause of death, in a certain number of cases, was a septicemia, causing hemolysis, with dark tarry blood which was unable to carry oxygen, and, therefore, death invariably resulted in a few days, without great loss of weight or marked emaciation—an acute, even peracute, attack. On the other hand, animals that lived through this first more or less septicemic period would invariably become afflicted with a more or less severe diarrhea or dysentery. These lived longer, became gradually weaker, and lost flesh; the pathognomonic symptoms were dysentery, weakness and slow cachexia, but not acute toxemia as in the first type. Other cases were of the mixed type, the attack being less acute, the symptoms of the hemolytic (septicemic) increasing more slowly and changing gradually into the diarrheal-dysenteric, finally terminating in death or recovery, as the case might be.

Fortunately the post-mortem findings of the two types of disease present beautifully distinguishable features.

Post-mortem notes.—The disease of the first or hemolytic type produces lesions characteristic of a hemorrhagic septicemia. Discharge from eyes and nose is often present. The blood escaping from cut vessels appears dark, tarry, does not coagulate well, and more or less pronounced hemolysis stains the serum. The blood-vessel walls permit escape of tinged serum and cellular elements into the adjacent tissues, thus causing the characteristic hemorrhagic extravasations found throughout the cadaver. In aggravated cases entire regions are found discolored in this manner. Blood extravasations into the subcutaneous and muscular tissues are frequently obscured. The Schneiderian membranes are dark red or bluish red, covered with hemorrhages. The mucosa of the larynx and pharynx shows hemorrhagic and croupous inflamation, and its epithelium is often eroded. Throughout the thoracic cavity, subpleural hemorrhagic extravasations attract attention at once; often the inter-costal spaces, especially on each side of the vertebral column, are stained dark blood color. Hemorrhagic or petechiated areas are found on the pericardial sac, on the myocardium and in the ventricles. The valves of the heart are often deeply stained. The lungs show, throughout their tissue, more or less marked areas of hemorrhagic inflamation and corresponding discoloration. The lymph glands are similarly infiltrated. In the abdominal cavity the serous layers are covered with blood extravasations. The blood-vessels are ribbonlike and are dark colored because the fluid escapes through the permeable vessel wall. The mucosa of the fourth stomach is intensely congested, shows numerous hemorrhagic areas and incipient ulcerations in the acute stage. Throughout the intestinal tract similar lesions are found—all evidently recent and acute, with extensive hemorrhagic extravasations under the mucosa or into the lumen of the bowel. The liver is usually engorged with blood and may appear mottled, showing regions of parenchymatous degeneration or biliary stasis.

The disease of the second or diarrheal type, on the other hand, will invariably present lesions typical of a severe gastro-intestinal disturbance, due to rapid, more or less extensive destruction of the mucosa by agamic multiplication of coccidia in the different parts of the intestines. If the animal has been sick 8 days or more, the cadaver shows marked emaciation. The eyes are clear but sunken. The abomasum, the duodenum, cecum and rectum are usually severely involved, while the lesions in the jejunum, ilium and colon appear less marked. The defects of the mucosa permit escape of blood through the destroyed epithelial layer. Destroyed cells, blood elements and serum, mixed with intestinal secretions and ingesta, form the thick slimy layer covering the mucosa of the affected parts. This layer has a more or less offensive odor and is a favorable medium for the multiplication of secondary (bacterial) invaders. Parts of the bowels involved in this manner can often be recognized as soon as the abdominal cavity is opened, as they have a peculiar

bluish-gray or slaty color, and appear quite anemic. Pleura, heart, diaphragm, liver and mesentery are pale, anemic, but bright and glistening, free from the characteristic hemorrhagic extravasations always found, and pathognomonic to the hemorrhagic-septicemic type. The vessel walls do not permit the blood to escape into the surrounding tissues and are, therefore, well defined and distended on a pale, anemic background. The blood is bright red and forms firm buff-colored clots.

Since to the first type are due the peracute and acute attacks, and to the second type the somewhat slower acute and chronic cases, it is evident that the diarrheal form supersedes the hemorrhagic-septicemic period. When animals die during certain stages of the pest, the lesions found on autopsy will be of a mixed type, approaching more the septicemic or diarrheal type, corresponding to the type of disease which predominates at the time of death.

If we remember and consider the clinical history and the causes producing the different clinical symptoms, they will in a large number of cases correspond to the autopsy reports, which permit us to recognize as cause of death (1) a hemolytic or hemorrhagic-septicemic, (2) a diarrheal, and (3) a mixed type of disease.

The course of the disease in all animals suffering from the diarrheal form can readily be followed by the type of diarrhea or dysentery. The microscope permits ready identification of the kind and approximate number of coccidia. These examinations can be made in a systematic manner, similar to examination of stools from human sources for bacilli or amebæ. Coccidia produce dangerous dysentery only during their asexual multiplication, where young immature asexual forms and merozoites are passed out in incredible numbers. When forms produced by sexual conjugation—macro-gametocytes, micro-gametocytes, oöcytes or the smaller cystic forms—begin to appear in the mucus, schizogony has reached its limit, and the host, if not too weak, will improve in a marked degree in two or three days, and recover.

Such cases could be recognized, studied, diagnosed and a reasonably correct prognosis made.

If some way could be devised to identify and to diagnose the septicemic cases, enabling us to form a proper diagnosis early, the study of the disease proper could then begin.

In an effort to determine what could be done, it appeared that some sero-diagnostic method would be indicated.

Dr. A. Marmorek,(4) of the Pasteur Institute in Paris, in 1909 diagnosed tuberculosis in humans by using rabbit and sheep

corpuscle-hemolytic-amboceptor, urine from tuberculosis patients as antigen, anti-tubercular serum as anti-bodies and guinea-pig serum as complement.

This method appeared to be well worth a trial. On March 14, suitable clinical cases being on hand, the method received its first trial. Dr. E. H. Ruediger, of the Bureau of Science, kindly furnished the hemloytic amboceptor. In titrating for the complement-deviation values, it was at once noted that the antigen—the urines from animals sick with this type of disease—dissolved the blood corpuscles with marked rapidity, so that it could not be used for this purpose. Since the urine of animals suffering from hemolysis had this property and it was found possible to heat such urines with only slight diminution thereof, the problem assumed a new and more favorable aspect.

After many trials it was found that 0.5 cubic centimeter of a 10 per cent normal salt solution and sheep-corpuscle emulsion, and approximately 5 cubic centimeters of fresh but filtered urine gave the best results. Urines can be heated to 60° or 70° C. for 30 minutes and lose but little of this property. They will then keep for weeks, although in my cases (about 250 samples) a marked diminution of the clearness of the reaction was noted after 20 days.

A series of suitable test tubes is taken. Into each is placed 0.5 cubic centimeter of 10 per cent sheep-corpuscle emulsion; 5 cubic centimeters of the urine to be tested is added and the tubes are set away at room temperature (20° C.) for 24 to 36 hours. A tube with 0.5 cubic centimeter sheep-corpuscle emulsion and 5 cubic centimeters of salt solution is used as one check, and another tube with 0.5 cubic centimeters sheep-corpuscle emulsion and non-reacting urine is used as another. The tubes must be kept in a perpendicular position.

In urine from animals that are not afflicted with the hemolytic type of the disease the blood corpuscles will settle in a button on the bottom of the tube, similar to the checks, which do it regularly. The urine above may be clear, hazy or even turbid. On the other hand, in acute cases of the hemolytic type, a very rapid and complete dissolution of the corpuscles takes place and the entire tube becomes bright red and translucent. When 5 cubic centimeters of urine dissolve 0.5 cubic centimeter of 10 per cent blood-corpuscle emulsion, this hemolytic factor can be expressed as $\frac{5}{5}=\frac{1}{10}$, showing a dangerous attack. Urines can be titrated as to the amount of sheep-corpuscle emulsion that they can dissolve. A factor of $\frac{2}{10}$, in the cases that I

have examined, invariably signified death in a few hours or the next day. Between these extremes, all kinds of degrees of hemolysis may be observed. The button may form and a dark-red zone, extending 1 centimeter above it, will indicate a moderate, not dangerous, attack. In other cases, the corpuscles settle into an indistinct dark-red, shallow area in the cupola of the tube, with a marked hemolytic zone, coloring two-thirds of the urine red. If samples of urine are taken every day, the course of the disease can readily be followed. These hemolytic periods are subject to marked variations. In artificially produced rinderpest (blood injections), the reaction is severe on the 4th or 5th day (occasionally sooner), maintains itself during 3 to 10 days, and becomes gradually less until at last the corpuscles settle rapidly into a firm button and the animal can be considered very resistent against an injection of approximately the same virulence. As long as the condition becomes worse the hemolysis in the tube increases; when the hemolysis decreases and a button of definite form appears, the animal is improving. As simple as this is, it constitutes an exceedingly valuable diagnostic aid. The urines are gathered in wide-mouthed bottles and filtered directly into the test tubes. These are labeled, heated to 60° or 70° C. for 30 minutes, cooled and tested as soon as desired, or stored away.

One tube alone will, of course, prove whether the process in question is developing in the animal or not; a series of tubes, however, will show to a nicety the course of the disease. Observations taken on probably 30 animals, in all stages of the disease, show that when executed carefully and cleanly this method is reliable and very practicable. I do not claim that it is a "specific" reaction, but it is a diagnostic method permitting the observation of otherwise invisible phenomena.

It will no doubt be asked why rinderpest should be here diagnosed when this paper discusses coccidiosis.

The two diseases are so intimately associated and so difficult to differentiate clinically that I hailed with great delight this diagnostic method, and thought that, being able to eliminate coccidiosis with the microscope and diagnose rinderpest by urine test, the study of either disease could really begin.

Dalupiri bull No. 3694, which had been carefully kept among the non-immune experimental animals, was noted to have a slight but persistent diarrhea beginning in an obscure manner about March 15. On April 22, the diarrhea persisting, the animal was isolated, and the evening temperature was found to be 39.6°; it remained above 39° in the evening and above 38° in the

morning for weeks. A dry scaly skin eruption appeared on the fore quarter and neck; at times there was a slight nasal discharge, and soon after the diarrhea became well established coccidia could be found in the feces. The animal lost a little weight, but was always bright, quarrelsome, relished its rations, and at times ate ravenously. Coccidia in great numbers were found in the feces, including many young asexual and a few cystic forms. This type of animal is especially susceptible to coccidian gastro-enteritis. It had been noted before, however, when animals of this type were used for rinderpest experiments at the veterinary research laboratory, that they had high temperatures, so that the Fuga cattle were preferred, and the Dalupiri animals were discarded. No attempts were made to identify the cause of the thermic rise. For this reason No. 3694 was a useful and acceptable addition to the animals under observation, to study the co-relation of the hemolytic and diarrheal types of the disease. This had heretofore been a difficult problem. Urine tests were made as follows:

Previous to April 15—negative.

Hemolysis extended on April—					
15.	18.	20.	24.	28.	30.
none	[a] 0.25	[a] 0.50	[a] 0.25	[a] 0.25	[a] 0.25
Hemolysis extended on May—					
2.	4.	6.	8.	11.	13.
[a] 0.25	none	none	[a] 0.25	[a] 0.25	none

[a] Length of tube.

This slight but persistent reaction was coincident with the finding of coccidia in the feces extending over many weeks. The animal was fed on good hay which temporarily lessened the diarrhea. The high temperature, the remarkable appetite, the dry, slightly scaly skin eruption, the presence every few days of more or less mucus with the different forms of coccidia and the slight but recurring attacks of hemolysis as demonstrated in the urine were all due to a naturally acquired coccidian infection. It is the first one that has come under our observation in the earliest stages.

This case of coccidiosis showed all the symptoms, in mild form, that a pronounced case of rinderpest presented—nothing was wanting.

On April 18 a medium-sized carabao, brought in from the country, came under observation. It appeared perfectly normal; the temperature was not markedly increased, but the feces were not constant in character, at times soft, at times coated with mucus, occasionally appreciable masses (not flakes) of mucus were expelled, and these showed schizogenous forms of coccidia in enormous numbers in every microscopic field. In the thin flakes of mucus, the sexual, cystic forms were numerous. The urine showed:

Hemolysis on May—			
18.	20.	22.	25.
none	none	very slight	[a] 0.25

[a] Length of the tube.

The animal was then taken away and could not be observed further.

It was decided to subject No. 3694 to a test inoculation of rinderpest blood, because it appeared that, if the diseases were identical, immunity would certainly have been produced between April 22, date of isolation, and June 11, date of injection of 5 cubic centimeters of virulent blood. The high virulence of this amount was demonstrated by the severe attack experienced by other animals in the same series.

The temperatures of the animal at the time of injection were 39.4° in the evening and 38.3° in the morning, which were too high, indicating a chronic, more or less serious disturbance. On the 4th day after the injection of virulent blood the temperature rose to 39.5° and 40.6°, respectively, and on the fifth day to 40° and 40.5°. Diarrhea became aggravated, dysentery began on the 9th day and rapidly increased in severity; still No. 3694 showed a remarkable resistence and was eating a little grass one day before it died—emaciated to a skeleton.

Post-mortem lesions were absolutely identical with those of rinderpest. Scrapings from the ulcerated abomasum, the duodenum, the cecum, the colon and rectum, however, showed young forms of schizogenous type of coccidia in countless numbers. All attempts to diagnose rinderpest correctly and to differentiate it from all other diseases will require further study and evidently a series of most carefully executed experiments and observations.

In the attempts to solve this important problem, another disease has been identified and means discovered to establish a

correct diagnosis, so that a careful study of coccidian gastro-enteritis, as found in these Islands, can now begin.

Coccidiosis, or to be more definite, coccidian gastro-enteritis, was observed as early as 1880 on high pastures in some parts of Switzerland. In 1892 Dr. Zschokké(1) (Veterinary School, Zurich) and Dr. Hess(2) (Veterinary School, Berne) published comprehensive articles in a Swiss veterinary periodical on the "red dysentery of cattle," caused by the schizogenous multiplication of coccidia in the epithelial cells of the intestinal canal. Hess states that during the year 1890, 200 cases occurred in the district of Saanen, of which 16 died; during the year 1891, 180 cases were noted, with a loss of 20. Most of the cattle made good recoveries in eight days, some in two to three weeks, while other cases lasted from two to three months. The animals became greatly emaciated and cachectic. Coccidia could readily be demonstrated in enormous numbers, especially in the abomasum, cecum, colon and rectum. Infected drinking water from swampy pastures was established as the cause. Hess quotes four instances where the infection was traced to hay, the cattle being kept in stables on dry rations. In a Swiss veterinary publication of 1908 appears a very interesting article on "red dysentery," or coccidian dysentery of cattle, from the pen of Dr. E. Züblein.(5)

His observations supplement those of the earlier writers and he arrives at the same conclusions as to cause and mode of infection. A short comprehensive article in English is found in Vol. II of Dr. Law's(6) "Veterinary Medicine" which is based upon the early observations of the Swiss veterinarians. Since then Dégoix(7), Kitt(8), and others have investigated and published articles on this subject. From time to time interesting articles by different veterinarians have appeared in the technical journals.(9, 10) Eustace Montgomery's(11) short, terse article (in English) is published in the Bulletin de la Societé Pathologique Éxotique, 1910, Vol. III, page 293; A. Balfour's(12) article on the same subject is found in the same volume, page 429. The organism causing the disease under discussion belongs to the phylum Protozoa, subphylum Plasmodroma, class of sporozoa (Leukart), subclass Telosporidia (Schaudinn). F. Döflein(13) in his standard work "Protozoenkunde," 3rd Ed., 1909, places them as 1st order Coccidiomorpha (Döflein), suborder Coccidia (Leukart). They are therefore related in some of their characteristics to the Hemosphoridia (Shc.) and Gregarinidæ. No doubt those interested in this subject will find F. Döflein's work the best source of information. Their com-

plex life cycle is well described and illustrated, but the nomenclature of different authors—as is usual—does not agree.

It would appear that the coccidia which were observed are not identical with *Coccidium oviforme* (*Eimeria stiedæ*). On three different occasions oöcytes with eight, free, circumposed, round spores were observed. Whether this will be found to be constant, or whether it was an artifact, only a careful observation will demonstrate. Since coccidia are classified by the number of sporozites formed and their methods of division, this point must be considered as very important in a final classification of these organisms.

Knowing to what class the coccidia belong, a close scrutiny of the parasite can be made, because *sporozoa* as a class come under the same general biologic laws. They all form oöcytes (sporozoites) and these are the forms that permit the termination of the life cycle outside the body of the host, and, through the formation of spores, transmit the disease by means of water and forage. Since sporozoites result only from sexual conjugation, the chronic carriers, in which schizogony is limited and therefore not dangerous to the host, are the distributors of the forms that infect the swampy pastures and, multiplying subject to the stimulus of more or less favorable environment, reinfect new animals and destroy some sensitive new host by the often incredibly rapid asexual schizogenous division.

On page 710 of F. Döflein's(13) work, third edition, the statement is made that many parasites, resembling sporozoids, found free in the blood stream, have been described as drepanidia while they probably were coccidia in certain stages of development, circulating in the vascular system.

If we take blood from an animal recovering from a severe attack of coccidian dysentery, we can, by careful centrifuging and by blood-corpuscle leaching methods, obtain these spores in appreciable quantities. They can also be recovered from feces by sedimentation methods. In urine they are found far more easily, but only the smaller forms, appearing as dense, small, cocci-like bodies under the oil immersion, can be obtained. The larger forms are held back, apparently by the kidney filter.

When spores are first liberated they are quite large, about one-half the size of an erythrocyte. They take eosin or carbolfuchsin stain, especially when first subjected to a mordant of chromic acid. They lose the color readily, however, 50 per cent alcohol or 2 per cent sulphuric acid decolorizing all the large forms in a few minutes. As the spores become more developed, they show denser capsule and become smaller. We must also

consider that coccidia are readily influenced to modify their method of division; Guillebeau(3) and Züblein(5) report that at 20° to 30° C. the usual division and sporulation take place in *Coccidium oviforme,* but at 39° the division into very small, sphere-like bodies is most rapid and reaches a point where the resulting spheroidal bodies cannot be seen by high power.

After careful study and consideration of the large amount of available material, their presence could be demonstrated in a satisfactory manner by the method mentioned above. Even oöcytes, showing freelying spores surrounded by the intact double-encountered membrane, were observed in washed blood sediment.

In regard to occurrence, Döflein(13) says that coccidia are distributed over the entire world. In these Islands they can probably be found in all animals, wherever mucus flakes can be detected by a careful microscopic examination of the dejecta. During the last dry season, the animals on a certain tract of land along the Pasig River showed normal feces. About two or three weeks after our early heavy showers all the immune cattle, Chinese and Indian, as well as sheep, goats, horses and later even hogs, showed marked constipation, the feces being passed in hard-formed masses, often hanging together on mucous strings, and in these flakes the sexual-division forms of coccidia were found in enormous numbers.

A herd of 21 carabaos, fine large animals, imported a few years ago from Pnom Penh, apparently in the best of health, were all constipated and the feces appeared coated or varnished. Examinations under the microscope always established the same diagnosis. Cattle from Mindoro were also markedly affected. Cattle from the Batanes Islands, especially a shipment of carabaos and cattle from Dalupiri, were greatly constipated and their feces, formed into small, hard, dense pellets, or rouleaux formation, were covered with blood-tinged mucus, which could be recognized with the naked eye. One of this lot, however, an old cow, had a marked attack of diarrhea, during which masses of mucus with the well-known schizogenous forms appeared.

This early constipated stage is pathognomonic of coccidiosis and is superseded by the dangerous dysentery only if the host is susceptible and his body cells cannot inhibit the rapid and destructive agamic multiplication.

A notable exception is to be recorded in chickens, which show the symptoms early in the coccidial season, usually by a muco-

sanguinous diarrhea with large intestinal mucous casts, in which the club-shaped merozoites alone appeared, often in rosette formation, not yet separated. The birds stopped laying, were dumpish and their combs were bluish or gray instead of red; they appeared as if they were going through a heavy molt, without losing their feathers.

It appears therefore that coccidiosis in its chronic form, although it has escaped notice so far, has an extensive distribution throughout these Islands. In this form it is practically harmless, although many ill-nourished young animals may be retarded in healthy development by an invasion, and the subphylum of sporozoa will no doubt soon be charged up with much of this loss on the part of our agricultural communities.

While chronic coccidia carriers are not seriously affected, having acquired immunity themselves, they infect the feeding grounds and watering places of susceptible animals, and more information on this phase of the coccidial life cycle must be obtained. We do not know the exciting cause, the stimulating factor, that produces epidemic outbreaks among cattle. From the numerous observations made in our rinderpest experiments, it would appear—remembering the peculiar methods by which coccidia can divide into most minute organisms (Züblein,(5) 1908)—that one part of their life cycle could be passed in the blood-vascular system and that their rapid multiplication in most minute forms produces the hemolytic form of the disease. This is superseded, if the host lives, by the diarrheal form, the latter being necessary to reinfect other hosts and transfer the contagion from one place to another.

Guillebeau(3) (1893) states that some animals succumb on the second day. This is impossible even if the epithelial cells are damaged by excessively rapid schizogony. A rapid multiplication in the blood stream of an organism which is ultra microscopic during a part of its life cycle, however, offers the best and most plausible explanation. Dr. Y. F. Löffler(14) (1911), in his dissertation on filtrable viruses, says that the different results obtained by various investigators relating to the filtrability of the virus of a certain disease may often be due to the fact that the virus from the same strain may be composed of larger or smaller particles, according to the stage of development at which it happened to be in the material that was filtered.

E. Montgomery,(11) in his article previously mentioned, in speaking of an epidemic outbreak of coccidiosis in East Africa,

states that clinically coccidian gastro-enteritis cannot be differentiated from rinderpest, but that rinderpest can be transmitted by blood inoculation, which is not the case with coccidiosis.

Our observations show that the history, development, clinical symtoms and post-mortem findings of acute coccidian gastro-enteritis and acute rinderpest cannot be distinguished, that they are identical, as Montgomery says. In one disease however, coccidia in enormous numbers can always be demonstrated in intestinal scrapings and slime from the abomasum, duodenum, cecum, colon or rectum, obtainable in large quantities on post-mortem examination.

We cannot deny that acute coccidiosis has invariably been associated with rinderpest inoculation. Our last cases, Nos. 3694 and 3714, died from coccidian gastro-enteritis of the most severe type after receiving a subcutaneous injection of 5 cubic centimeters of rinderpest blood.

Since we have been able to recognize coccidiosis, it has never been possible to find a case of rinderpest without the presence of these organisms in great numbers.

Animals immune to rinderpest have, in the large majority of cases, been observed to be periodic carriers, or secretors, of coccidia in different forms. As examples, may be cited bullock No. 3554 and the Nellore Indian Cattle from the Iwahig Penal Colony on the Island of Palawan.

Of four guinea pigs that were inoculated on April 21 with blood from spore-carrying cattle, two died about June 12 from coccidian dysentery, one died from pneumonia, and one is still alive and doing well. Dr. E. L. Walker's guinea pigs, kept in the same room and fed the same way, have never shown any disturbance; Dr. Ruediger, a careful observer, has assured me that none of their small experimental animals have died from similar trouble.

Many authorities have also arrived at the conclusion that rinderpest cannot be a bacterial disease, that it belongs to the scourges due to protozoan invasion. The peculiar bahavior of animals susceptible to rinderpest indicates that they have only a lesser or greater resistancy. The numerous "relapses" observed in the Calamba outbreak were nothing else than reinfections due to infected pastures. This does not correspond with bacterial immunity but finds a ready explanation when the general laws underlying the acquirements of immunity—or to be exact, resistance—against protozoan diseases are considered.

A good illustration of nature's method of producing immunity

against protozoa is found in our southern States where cattle inoculated by ticks with piroplasmosis for generations have acquired a very high resistance.

In the Tropics, malaria is the cause of many deaths among children, while the adult population is very resistant, although being very often carriers and susceptible to very large doses of infected blood.(15)

Staff veterinarian F. Mrowka(16) (1914), writing from Tsingtau, where he had ample opportunity to observe the East Asian rinderpest, says:

> No doubt can exist, that the virus is found in the body in latent forms, that the cause for relapses is to be looked for in the mucosa of the abomasum and that its virulency is reëstablished by excessive exertions or changed conditions of life which affect the immune animals unfavorably.
>
> This explains why animals, able to resist artificial and natural infection, and therefore apparently immune, occasionally become sick with rinderpest, so that the words "immune to rinderpest" really mean afflicted with rinderpest in latent form.
>
> We must distinguish virus carriers and virus secretors. All animals immune to rinderpest, though absolutely harmless to their surroundings, may have a relapse and thus become virus secretors. This peculiarity identifies rinderpest as one of the many protozoan diseases.

It is evident, then, that it will be very difficult to separate rinderpest from coccidian gastro-enteritis.

I wish to express here my thanks to Director Alvin J. Cox for the freedom of the Bureau of Science laboratories, to Dr. E. L. Walker, for many attentions and ever-ready words of encouragement, and to Dr. E. H. Ruediger, Dr. J. A. Johnston and Dr. Otto Schöbl for their kind assistance.

This work and these observations were possible only through the interest and suport given by our chief veterinarian, Dr. Stanton Youngberg, and I desire to express my appreciation of his aid.

I hope that these notes will promote an advance along rational lines against a dangerous, disturbing factor in animal husbandry and that they will be of assistance in acquiring more knowledge and a better understanding of this class of disease.

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CURRENT NOTES—SECOND QUARTER.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao Experiment Station.

SHIELD BUDDING TROPICAL FRUITS.

As noted elsewhere in this issue of the REVIEW experimentation in vegetative propagation of tropical exogenous fruits is a feature of the work at the Lamao Experiment Station, and the following species were in 1915 successfully shield budded for the first time: bignay, *Antidesma bunius;* calumpit, *Terminalia edulis;* iba, *Cicca disticha;* mabolo, *Diospyros discolor; Flacourtia cataphracta;* bael, *Aegle marmelos;* vilatti, *Feronia elephantum;* banauac, *Uvaria rufa.* Detailed information relative to the budding of each of the above species, as a result of the experiments, is given below, as well as to the budding of the tamarind, *Tamarindus indica;* cashew, *Anacardium occidentale;* barobo, *Diplodiscus paniculatus;* seagrape, *Coccoloba uvifera;* camia, *Averrhoa bilimbi;* santol, *Sandoricum koetjape;* and hondapara, *Dillenia indica.* The tamarind was first shield budded by the writer in 1905, in Miami, Florida and the work verified here; the cashew in 1912 at Lamao; the remaining species were first budded successfully in 1914.

By "petioled budwood" is understood a twig cut at the time of budding and the petioles cut off close to the bud at the time of the insertion of the bud, as for instance in the citrus fruits, avocado, guava, etc. By "nonpetioled budwood" is meant a twig, the leaves of which were cut off while still on the plant some time previous to the date of budding, say three weeks, and from which in consequence the petioles dropped and a scar formed. Nonpetioled budwood should not be cut from a plant, or buds from it inserted, until the scar is well healed. (See this REVIEW, Vol. VIII (1915), No. 1, p. 59.)

Bignay, *Antidesma bunius.* Use petioled, green, smooth, but fairly matured budwood with brown-colored lenticels; cut the buds 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Calumpit, *Terminalia edulis.* Use petioled, barely mature, green

and tomentose to smooth budwood; cut the buds 4 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

Iba, *Cicca disticha.* Use nonpetioled, fairly matured budwood, green to turning brown, smooth; cut buds rather large with ample woodshield, not less than 4 centimeters long; age of stock at point of insertion of bud unimportant.

Mabolo, *Diospyros discolor.* Use petioled, fairly mature budwood, but with pubescence still present; cut buds 4 centimeters long and insert preferably at a point where the stock is still green or at most streaked with gray.

Flacourtia cataphracta. Use petioled, matured, grayish to brownish green budwood; cut buds 3.5 centimeters long; age of stock at point of insertion of scion unimportant.

Bael, *Aegle marmelos.* Use petioled, thornless green or purplish, fairly mature, not old and hard budwood; cut buds 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

In all probability the bael could be successfully budded upon the taboc, *Aegle glutinosa,* which is very drought resistant and is indigenous to the Philippines.

Vilatti, *Feronia elephantum.* Use petioled, turning greenish or grayish, just mature, preferably spineless budwood; cut buds 3 to 3.5 centimeters long; age of stock at point of insertion of bud unimportant.

Banauac, *Uvaria rufa.* Use well matured, dark brown, nonpetioled budwood from which the tomentum has disappeared; cut buds 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Tamarind, *Tamarindus indica.* Use petioled, well matured, brownish budwood; cut buds 3 centimeters long; age of stock at point of insertion of bud unimportant.

Cashew, *Anacardium occidentale.* Use nonpetioled, mature, grayish budwood; cut buds 4.5 centimeters long and insert in stock at a point of approximately the same age and appearance as the scion.

Barobo, *Diplodiscus paniculatus.* Use petioled, mature, brownish to grayish budwood; cut buds from 3 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Seagrape, *Coccoloba uvifera.* Use preferably nonpetioled, mature, but green and smooth to turning grayish budwood from slender twigs; cut buds 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Camia, *Averrhoa bilimbi.* Use nonpetioled, matured, brownish

or grayish, still downy budwood; cut buds 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Santol, *Sandoricum koetjape*. Use nonpetioled, fairly mature, slender budwood turning brownish, grayish and rough; cut buds 3.5 to 4 centimeters long and insert in stock at a point of approximately the same age and appearance as the scion.

Hondapara, *Dillenia indica*. Use nonpetioled, slender, fairly mature, green to brown, hairy budwood; cut buds from 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

THE DISTRIBUTION OF THE RAINFALL IN THE PHILIPPINES.

As an aid to the prospective planter unfamiliar with the climate and the foreign seed and plant introduction work in the Philippines, the recently issued "Annual Amount and Distribution of Rainfall in the Philippines" by the Rev. Miguel Saderra Masó, S. J., Assistant Director of the Weather Bureau, prepared under the direction of the Rev. José Algué, S. J., Director of the same Bureau, is one of the most valuable publications published by the Government in the Philippines.

We learn from this publication that, generally speaking, the western part of the Archipelago is characterized by a dry winter and spring, and a wet summer and autumn, while in the eastern part there prevails the winter and autumn rain type.

The Philippines have a mean annual precipitation of 2,400 millimeters, with a minimum rainfall of 900 millimeters in Zamboanga, and a maximum of 4,500 millimeters in Baguio. It is true, however, that these figures do not represent the rainfall for a region of any considerable area, for the values for the driest and rainiest regions of the Philippines of any considerable size are represented by 1,300 and 3,900 millimeters, respectively. Excepting the Island of Cebu, the northern and western coasts of Mindanao and the Jolo group, where the average rainfall is below 2,000 millimeters, all the northern, eastern and western coasts receive an annual mean rainfall of above 2,000. In the low altitudes in the interior of the larger islands the precipitation seldom reaches 2,000, while in the highlands above 200 meters it ranges between 2,000 and 3,000 with a maximum of 4,000 millimeters in the Benguet plateau in northern Luzon at an altitude of 1,400 meters. In certain sections of the eastern and southeastern coasts of Luzon, eastern Samar and northeastern Mindanao, the rainfall averages above 3,000 millimeters. There are no large regions especially dry in the interior of the large islands, or long periods of extraordinary drought.

Broadly speaking, the heaviest precipitation occurs during the summer and fall, from June to November:

During the winter months, December and January, the rains cease on the western part but they continue to fall abundantly on the eastern and northern coasts, thus constituting for the regions facing to the Pacific Ocean and to the larger inland seas quite a second rainy season. February, March, and April are generally the driest months over the whole Archipelago, although as soon as the sun reaches the Northern Hemisphere and the thermal focus is advancing northward, local thunderstorms become more frequent and during May cause heavy showers, especially in the interior of the large islands.

In concluding the leading article, the climate of the Philippines in respect to the rainfall is summarized into three divisions:

(1) Regions with the cyclonic rainfall only, where a dry season practically lasts for six months—December, January, February, March, April, and May. The western coasts of Luzon from Cape Santiago to Cape Bojeador, including the shores of the Manila Bay and the southern coast of Luzon corresponding to Batangas; the central plains and moderately high lands of Luzon from Batangas to Nueva Ecija and Pangasinan; the region of Benguet and the Mountain Province; the western coasts of Mindoro and western Panay and southwestern Negros and the Calamianes groups.

(2) Regions which receive cyclonic and winter rainfall with a relatively dry season lasting only three months or less—generally March, April, and May. The northern and eastern coasts of Luzon, with the Cagayan Valley and Nueva Vizcaya; the Batanes and Babuyanes Islands; the most of southeastern Luzon; eastern Mindoro, Romblon Island, northern Panay, and Negros, northern Cebu, western Bohol and northern Mindanao.

(3) Regions with more or less even distribution of rainfall during the year with the minimum during the months of March and April or in August. The southeast end of Luzon; the eastern Visayas, Masbate, Samar, and Leyte; the northern and eastern part of Bohol, Cebu, Negros, and Panay, eastern and southern Mindanao, Basilan and Jolo.

The publication in question consists of 42 pages, with 76 rainfall tables, and is accompanied by a comprehensive rainfall map with 52 graphic charts by which one can see at a glance the annual mean rainfall of most sections in the Philippines.

We heartily recommend the above-mentioned publication to all who are interested in the climatology of the Philippines.

NOTES ON THE OUTLOOK FOR THE CITRUS FRUITS IN THE PHILIPPINES.

Most people are under the impression that a limited district around a few towns in Batangas is the only section in the Philippines where oranges will succeed, pointing to the inferior fruits that are grown everywhere else, and no doubt the outlook is dismal enough to the casual and superficial observer. Never-

theless, after more than four years' close observation of the conditions here and of the Philippine grown citrus fruits, and after several years' residence in Florida, the writer ventures the opinion that very considerable areas in the Archipelago are well adapted to citrus culture, and that the chief difficulty consists largely in planting the right varieties and using the stock best adapted to a locality.

There can be no question as to the adaptability of the Batangas mandarin district to the mandarin, but it is a peculiar fact that, at least so far as the writer is aware, with the exception of a few trees of a local citrus fruit known as "tizon," the mandarin is the only species in the genus that produces a really good fruit there. In this region the orange is of mediocre quality, the few lemons and limes are poor, and the pomelos grown are so dry and tasteless as to be inedible from a European point of view. Consequently, when it is remembered that in south Florida, in a similar climate, though a widely different soil, one may find oranges, mandarins, limes, lemons and pomelos growing in close proximity, all of good to very good quality, and when it is also recalled that all Philippine citrus trees are seedlings, it certainly appears extremely probable that the ancestry of our fruits is very largely responsible for the quality, and that, for instance, the Batangas mandarins are of a very good strain while the related fruits in the same region are of poor parentage. Certainly it seems unbelievable that if the strains were equally good, land that produces such superior mandarins should at the same time yield such execrable pomelos and lemons. And, speaking now of other parts of the Archipelago, the fact that individual seedlings here and there bear fruits of good quality, while other trees of the same species in the same section and under the same conditions, bear fruit that is almost inedible, certainly points to the adaptability of the land to the species in question and also to the fact that individuality in seedlings plays a very important part in the quality of the fruit. This in turn serves to emphasize the great importance of budding the seedlings to good varieties.

Insipidity and lack of juiciness are the two cardinal defects in the Philippine citrus fruits, broadly speaking; nevertheless, pomelos of excellent quality have been obtained from Bataan, and we have also reports on good authority that unexcelled pomelos grow in Bongabon, Nueva Ecija, and very well-flavored and juicy limes have been received from Davao and the east coast of Mindanao. In Sumilao, Bukidnon, in the same island, the writer saw, two years ago, a lime tree that was unrivaled

in productiveness, with a fruit on a par in quality with the famous (in the United States) lime from the Florida Keys, lying to the southeast of Florida. In the same town oranges of good flavor and quality were found, though somewhat seedy. These were produced on trees grown from seed imported from Spain. Other oranges and pomelos of Philippine origin in the same town were dry and tasteless. Lemons have been sampled from Masbate that for shape, coloring, thinness of skin, and juiciness, were unsurpassed, but being a seedling strain, they were so bitter as to make them unsalable. If we remember rightly, oranges were received from southern Tayabas a year ago, grown from imported trees that left little to be desired. The fruit of a California Navel orange that has fruited in Manila was even juicier than California grown fruit, its one defect being lack of sprightliness.

In the early days of the Bureau a number of citrus varieties were introduced. A few pomelo and lemon trees remained at the Lamao experiment station when the writer arrived in 1911. The pomelo trees were large and in excellent condition, but have never even bloomed, showing that not all imported varieties may be depended upon to be profitable here. The lemon trees bore a few fruits in 1910 and 1911, but developed gummosis and did so poorly generally that all were removed except one. This has now grown into a tree with a spread of about seven meters and last year carried a fair crop of fruit of fully the excellence of imported lemons. That it is the *variety* and not the *soil* that has here determined the quality is demonstrated by the fact that we have growing, in an adjoining field, under exactly the same conditions, several lemon varieties of native origin that are utterly worthless.

NEW ANNONAS FOR THE PLANTBREEDER.

In the Philippine Agricultural Review for July, 1913, a paper was published by the writer containing a list of 49 species belonging to the family ANNONACEÆ, utilizable for plant breeding work. Mention was then made of the large number of edible species in the genus *Annona,* and it was stated that "it is quite probable that there are several others that when better known may also be found to be of more or less value." Since then three new species have been found that may be of value to the breeder, one of which, as a matter of fact, was described years ago. The description of all has been obtained from "Classification of the Genus Annona, etc." by W. E. Safford, Contr. U. S. Nat. Herb. Vol. XVIII (1914), part 1.

Annona scleroderma Safford. A spherical to oblate fruit, 6.5 centimeters long and 9 centimeters in transverse diameter, with a hard shell, 6 millimeters thick, according to a line-drawing accompanying the description, the surface of which is divided into polygonal areoles by raised ridges. Indigenous to Guatemala.

Most annonas have a soft tender skin and this hard-shelled species is therefore of more than ordinary value.

A. jahnii Safford. A tree 4 to 6 meters tall, of spreading habit. The fruit is ovoid, small, attaining a length of 7 centimeters, muricate, rufously or ferruginously pubescent; pulp edible, sweet, and of pleasant flavor. The species is native to the coastal land of Venezuela and Colombia.

A. globiflora Schlecht. Anonilla. A spreading shrub 1 to 2 meters high. The fruit is small, 3 to 4 centimeters in diameter, spheroid or broadly conoid, muricate or mammilate; the pulp is edible but scanty. The anonilla is native to Mexico.

A. manirote H. B. K. is here considered a synonym of the soncoya, *A. purpurea* Moç. et Sesse, of which a short description appeared in the Philippine Agricultural Review for September, 1914. From the evidence at hand it seems likely that *A. involucrata* Baill. and *A. prestoi* Hemsl. will also in all probability be reduced to *A. purpurea*.

A new genus, *Fusaea*, is established by Mr. Safford, to which he has transferred the pinaioua, *Duguetia longifolia* Baill., an edible, well-flavored fruit originally described by Aublèt in 1775.

THE "GIANT" CHERIMOYA.

This is a variety of cherimoya that is being grown to some extent in Queensland, Australia, and which has been reported to bear fruits of excellent quality 2.3 kilograms in weight. In order to obtain an authoritative statement relative to this variety, which was imported two years ago and last year successfully crossed with the atemoya at the Lamao Experiment Station, the writer communicated with Mr. Howard Newport, instructor in tropical agriculture in Queensland, Australia, for information relative to the "Giant." According to Mr. Newport, who courteously sent a photograph of the fruit, while there are no authentic records available, it is believed that the "Giant" is a hybrid between a cherimoya in the Fiji Islands and a large sugarapple. At the Experiment Station in Kamerunga, Queensland, the "Giant" has been found a shy and erratic cropper but of good quality. The photograph received showed a fruit with prominent carpels, weighing 1.2 kilograms, and

Mr. Newport states that he has heard of fruits weighing 1.4 kilograms, which is probably nearly if not quite the maximum weight of this variety. However, an annonaceous fruit of this size is more than sufficient, since a few large fruits have a greater tendency to break the branches of a tree than an equal weight distributed among many smaller ones. Furthermore, small fruits are usually more salable than large ones.

NOTES BY CLEVE. W. HINES, M. S., Station Superintendent.

SUGAR NOTES.

The progressive firm of Alexander and Baldwin of Hawaii has recently added a new official to its personnel with the designation of Auditing Chemist. The duties of this functionary will be somewhat varied but in general will be to give advice to the plantation managers on the various questions arising in the different lines of his duties. His further duties will be to plan and supervise field experiments in addition to his regular work about the mill and with sugars.

It is announced that Mr. S. S. Peck, the eminent chemist of the Hawaii Planters' Association has been named for this position.

Machinery of the very highest efficiency is rapidly replacing the antiquated designs in many of the sugar-houses of Cuba and it is largely on account of this progressive spirit that such remarkable results are secured in their factory workings. It is interesting to note in this connection that every province except Havana contains one or more mills equipped with grooved rolls of the Messchaert type.

An item of very great expense to the sugar producer is the harvesting of his crop. Many machines have been designed to accomplished this task at a decreased cost but each of these failed in some particular or other until, during the past year, it was announced that the Luce cane-harvesting machine has been proven a signal success under Louisiana conditions.

It is claimed that this machine will cut, strip and top from 150 to 200 tons of cane per day and handle very satisfactorily even reclining cane.

Mauritius has long been noted for its production of sugar, but it is only of recent years that renewed interest has been shown in this industry and special efforts put forth with a view to the manufacture of high grade sugars directly from the plan-

tation. This is now accomplished by the use of the phosphoric and sulphurous acid methods.

The sugar industry of Argentina has grown to such magnitude that in 1913 more than two hundred and seventy six thousand tons of sugar were made. The rendiment for that year was 8.8 as against 6.9 the previous year. There are located in Argentina 42 sugar factories of which 38 were being operated in 1913.

The acid-thin-juice process used in connection with the carbonitation system as elaborated by Harloff has given excellent satisfaction in Java and many other countries. This or a similar method could be installed to very great advantage in factories of the Philippines which now make test sugar. They would thus be able to reap the benefits of a better product for direct consumption instead of bearing the expense of transporting their low grade sugar to the States, refining it there, and returning it to these Islands besides paying the middlemen's and agents' profits.

NOTES BY H. O. JACOBSON, Chief of Plant Industry Division.

COÖPERATION.

In recent years we have become familiar with the word "cooperation," particularly with reference to its application in agricultural activities.

In current news we learn that in the United States of America there are today at least 8,500 agricultural coöperative organizations through which, in the year 1914, agricultural products exceeding the huge sum of two billion pesos in value were marketed.

Comparatively young Americans can recall hearing many disparaging and discouraging remarks directed at propositions of this nature, the self-appointed critics confidently asserting that farmers could never learn to do business except individually. But today, in the more notably progresive agricultural regions, the new comer affiliates with the local organization quite as a matter of course.

With but few exceptions, coöperative organizations have resulted because of unstable markets. After a trial with legislation as a corrective measure, the farmers have decided that the remedy must be found among their own number, and organization has begun.

Such organizations, being therefore evolved primarily as defensive measures, have largely retained a rather selfish characteristic which may easily become a weakness.

Naturally, there are two sides to a bargain, and the consumer is at the mercy of the producer except that he can substitute other goods for those he has commonly used.

With a marked tendency on the part of producers' organizations to standardize their product with a view to increase profit only, the consumer is increasingly forced to accept a product that ships well or a better-yielding variety in preference to a particularly meritorious product; besides that, the consumer finds his choice of varieties constantly restricted.

The business world is gradually awakening to the value of service, that is to say, they are beginning to realize the consumers' view point and are learning to coöperate with the consumer.

For that reason, it is well for the producer to remember that the consumer eventually bears the entire burden of the cost and is justly entitled to having his preferences recognized.

ANOTHER SOURCE OF OIL.

The search for oil producing material, accelerated by industrial hunger for a cheaper product to supplant those which in turn have become too expensive because of their utilization as food, has brought to light many varieties of plants which have heretofore been given little consideration.

In the British Trade Journal we learn that in Argentina they have investigated the physic nut, *Jatropha curcas,* finding it drought resistant, not injured by locusts or ants and easily cultivated.

The yield of oil per hectare is said to range from two to three metric tons.

The seed yields 49.3 per cent fat and can be used advantageously in soap manufacture and in pharmaceutical and industrial products.

This plant is widely distributed in the Philippines and thoroughly naturalized, but so far there has been no demand for its seeds.

THE SOIL MINER.

An old definition of the word "farmer" is that he is one who collects taxes. Of late a new term has been used "soil miner."

Seriously considering the question, one must conclude that there are many, indeed, who deserve the title "soil miner."

Consider the average grain grower; he plants seed such as he can readily obtain, and by grace of sufficient sunshine and rain, a crop of grain is produced. He removes the grain and the straw from the field and sells it, converting this material into silver and gold.

In calculating the value of this product, the cost of labor and use of implements enter, but these elements also must be considered in the mining of silver and gold.

By growing the crop of grain, certain amounts of plant foods (minerals) have been permanently removed from the soil, diminishing the productive power of this soil to a certain extent.

Wherein does this type of farmer differ from the accepted type of miner, except in method?

The soil miner type of farmer certainly taxes the soil and future generations.

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The Philippine Agricultural Review

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SPECIAL ARTICLES

HISTORY OF CANE VARIETIES IN THE PHILIPPINES

By C. W. Hines

CORN IMPROVEMENT IN THE PHILIPPINES

By H. O. Jacobson

HYBRIDIZATION OF ANNONAS

By P. J. Wester

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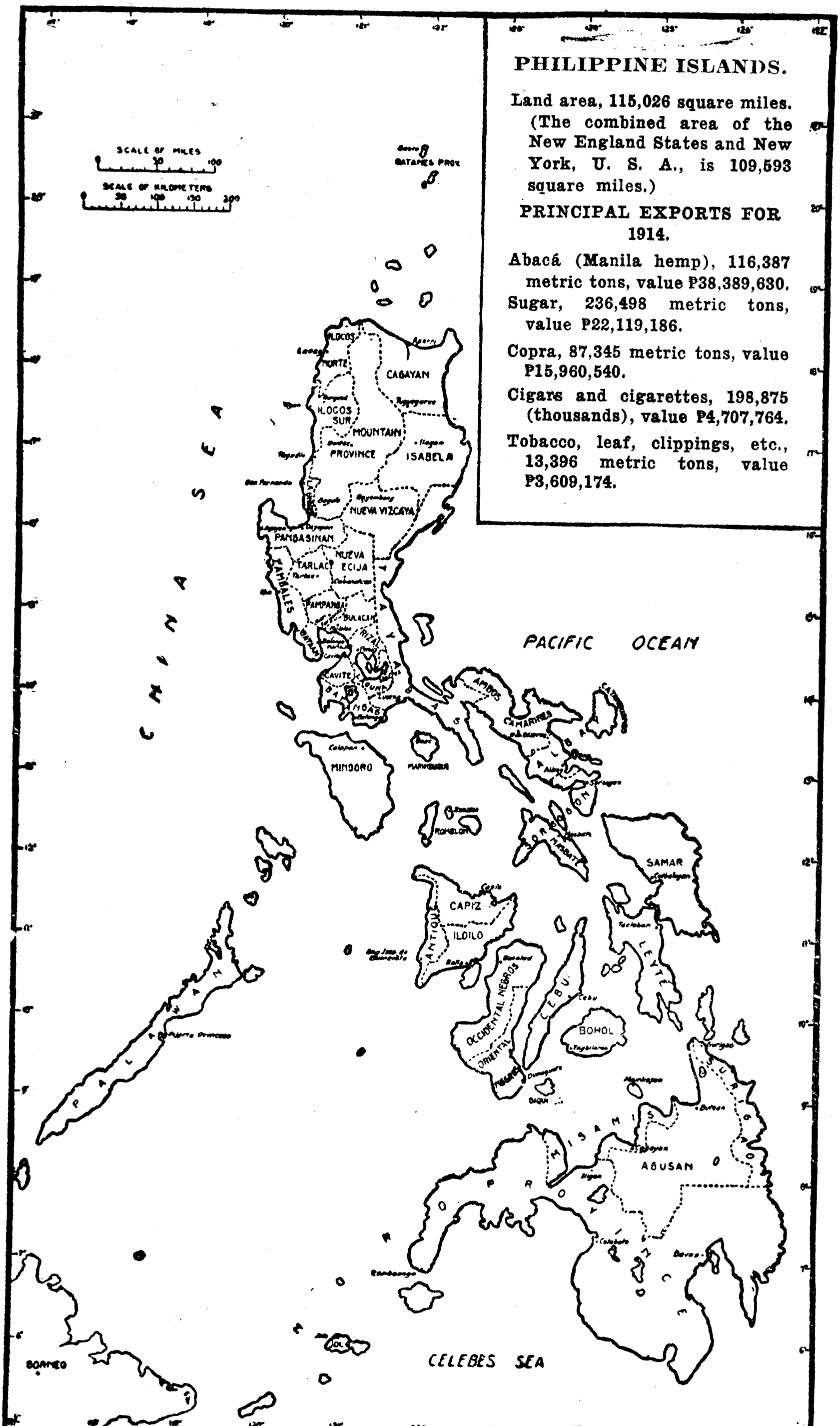
PHILIPPINE ISLANDS.
Land area, 115,026 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1914.
Abacá (Manila hemp), 116,387 metric tons, value ₱38,389,630.
Sugar, 236,498 metric tons, value ₱22,119,186.
Copra, 87,345 metric tons, value ₱15,960,540.
Cigars and cigarettes, 198,875 (thousands), value ₱4,707,764.
Tobacco, leaf, clippings, etc., 13,396 metric tons, value ₱3,609,174.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
CHINA SEA
PACIFIC OCEAN
CELEBES SEA
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
TARLAC
NUEVA ECIJA
ZAMBALES
PAMPANGA
BULACAN
RIZAL
CAVITE
AMBOS CAMARINES
MINDORO
ROMBLON
SAMAR
CAPIZ
ILOILO
ANTIQUE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
LEYTE
PALAWAN
AGUSAN
MORO PROVINCE
BORNEO

UNIV. OF MICH.

Yellow Caledonia sugar cane at Alabang Stock Farm. Age 11 months. November, 1914.

THE PHILIPPINE

Agricultural Review

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THE PRESENT-DAY SIGNIFICANCE OF ECONOMIC ENTOMOLOGY IN AGRICULTURE.

One of the subjects connected with the science of agriculture which has had a rapid growth within the last half century is the allied science of economic entomology. Synchronously with the development of transportation facilities and the shipment of large quantities of plant material from place to place has occurred the introduction of unheard-of pests from remote regions and well known pests from regions close at hand, while with the advancement of intensive farming and the breeding of early or late maturing varieties of certain crops, has come the apparent increase of native pests brought about by the changed conditions.

In earlier days entomology was looked upon as a pastime for the spare moments of those who cared to turn their attention to it or as a business confined to dusty museums, without any practical application whatever; the true significance of the study was not then apparent. At that time entomology was principally of the kind we now designate as systematic, the pure science as contrasted with the applied, dealing mostly with the structure and classification of forms of insects, much less with their life histories, very little with their possibilities as destructive agents and still less with the matter of waging active warfare against them.

Gradually the practical side developed and has since continued to develop until at the present time economic entomology is recognized by agriculturists as an important adjunct to the study of the actual crop production, without some knowledge of which the cultivator of any plants is likely to meet with obstacles before his harvest is over or his products in the hands of the consumer.

It has been estimated that on the average ten per cent of every crop is a total loss due to the ravages of insect pests. A large part of this damage is so constant, is produced by insects so inconspicuous or hidden, so scattered over large areas or various seasons, that the agriculturist may not know of its

existence, or at any rate, does not figure it other than as a perfectly normal factor in crop production.

On the other hand, there are pests like the locusts here in the Philippines, like the chinch bug of the grain belt of the United States, like the tse-tse fly of Africa, whose depredations are so marked that it is impossible not to recognize them for what they are.

Midway between these two extremes is a vast assemblage of insect pests, some of them constant or of wide distribution, others sporadic or local in their outbreaks, but all of them injurious or capable of becoming injurious. It is with all of these, including both extremes, that economic entomology has to deal, as well as with other insect forms which, although not pests, are yet of practical importance.

The problem is a large one. The number of different species of insects has been placed at somewhat approaching two million. Many of these are very restricted in their habitat; some of them are cosmopolitan. They must be classified and named, for in the knowledge of the relationships of animals very often comes a clue to the best manner of combating them. This is more particularly the work of the systematist but the economic worker must be versed enough in it to know and recognize the forms with which he has to deal. The insects must be reared and their life histories recorded for in the study of the mode of existence of certain pests there is most likely to be uncovered the weakest spot in the defense against which the attack may be directed with greatest success. This is the most essential branch of the study. Exhaustive studies in laboratory and field with parasites and predaceous enemies, studies frequently requiring investigations carried around the world, must be made to determine what natural checks may work upon the pest. The results of meteorological changes to insect life must be understood. Chemicals must be tried out to find their effectiveness as insect sprays, and the possibilities of cultural methods or farm practice for the control of pests must be studied. Finally the results of all this work must be arranged, tabulated, weighed and put before the public.

The questions may be asked, "What good will it do even then? What good has it ever done?" "Are there sufficient benefits to be derived from this work to justify it?" The answer may be found by citing one or two instances.

In 1868 there was introduced into California upon some trees imported from a foreign country, a species of scale insect which spread itself over the state and twenty years later was so

prevalent and abundant that it threatened to destroy the citrus industry of that region. Men were sent out to discover the native habitat of the species and to learn what forces, if any, kept it under control in its own country. It was learned that the scale was a native of Australia and that in Australia a certain ladybird beetle was active in suppressing it. Some of these beetles were introduced, bred and distributed throughout the citrus groves of the state and so efficiently did they operate that the scale was brought under control and has never since become a menace in that region. Here knowledge of the life history, habits and enemies of the insect resulted in saving a statewide industry. Such a system as this, however, works out only under peculiar circumstances.

The Hessian fly is a serious enemy of wheat and where its attacks are pronounced it sometimes destroys whole fields of that cereal before they have much more than begun their growth. A study of the life history of this species revealed the fact that the adults of this fly appear at certain definite seasons, and lay their eggs in the wheat plants. Working from this point it was found that if the wheat is not planted until after the flies have made their appearance, these insects are forced to seek other grasses and by the time the wheat is above ground the danger from this source is past. Adoption of this method of procedure forestalled the crippling of wheat production in certain places.

Some problems are yet unsolved. Owing to ill-timed legislation the fight against the gipsy moth in the New England states was curtailed just as it was reaching a period of control and the effects of delay have never yet been overcome. The campaign against the cotton-boll weevil in the Gulf States is still progressing, and is beginning to show definite results. If recommendations made by entomologists had been followed when first offered, the pest would never have gotten the start it has now. The grape phylloxera in Europe, the San Jose scale in America, the migratory locusts of this country and of other parts of Asia—the warfare against these is continuous and still the pests are present. Nevertheless, if the efforts which are being expended against them should cease, if the assistance which economic entomology has offered were discarded, the result would be an incalculable loss to the agricultural activities of the world. Entomology is no longer purely a diversion or an abstract science, it is an economic, practical and definite science with an application so important and well defined that it ranks second to none among the coadjutants of the world's indispensable industry, agriculture.

HISTORY OF CANE VARIETIES IN THE PHILIPPINES.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

Sugar cane was found under cultivation in the Philippine Islands when they were discovered by the Spaniards in 1521, and for that reason no definite knowledge of the introduction of cane growing can be ascertained. From the methods and implements employed in early times, however, it is evident that the industry was introduced from the coast of China.

The history of the cane varieties under early cultivation is even more difficult to trace. It is possible that some of the varieties might have originated here as seedling cane or from bud variations, but it is more than probable that different varieties were brought here from time to time by travelers from other East Indian Islands, and from the Chinese coast.

A small sugar experimental station known as "La Granja Modelo" had been established at La Carlota in Occidental Negros by the Spanish Government, but unfortunately during the period of unrest a few years prior to American occupancy, this station, together with its equipment and many of its records, was destroyed by fire. The few reports still available fail to throw any light on the subject of cane previously under cultivation, or varieties which might have been introduced by that institution.

It is presumed by some that the home of the sugar cane may have been in these Islands, and that some of the large grass-like plants still found growing over various sugar districts are very closely related to that plant. The highest developed of these plants is known as the "Tigbao Mestiza," which was thus named from the fact that it was supposed to be a natural hybrid between the "tigbao," a large grass-like plant, and the sugar cane. This supposed hybrid grows very erect, attaining a height of from three to four meters, and produces a stalk quite small in diameter. The internodes are long and deeply grooved and the stalk is slightly zigzag. The nodes are large, often containing rudimentary rootlets. When mature it contains as high as 9

per cent sucrose and averages about 16 per cent of fiber. Plate No. IV, *a*, shows a view of this cane taken at maturity.

There are a number of cane varieties under cultivation over the Philippine Islands which are designated as "native cane" since they have been under cultivation by the Filipino planters from time immemorial. Many of these vary greatly from each other in their appearance and characteristics of growth. Among the most striking examples may be mentioned the "Inalmon" or "Manila black," which has a very dark color; the "Luzon White," which varies from a green to a yellow straw color, depending upon its exposure to sunlight; the "Negros Dark Purple," which is very dark purple in color and is grown extensively in the sugar districts of the Islands of Negros; the "Cebu Light Purple," which is a light purplish cane extensively cultivated in the Island of Cebu; and the "Striped Leyte," or "Striped Ambos Camarines," which is a striped variety of cane resembling somewhat the striped Singapore, and is grown to some extent in the Island of Leyte and the Province of Ambos Camarines in the southern part of the Island of Luzon. A brief description of the different varieties will be given later in this article.

In the absence of records to indicate the contrary, it is presumed that until recent years no specific attempt was made to introduce into the Islands proved varieties of cane from other countries or to produce seedling varieties here. Indeed it was only comparatively recently that the seed of the sugar cane was found to be occasionally fertile and could be made to produce new varieties. This condition was discovered and the first new varieties were produced almost simultaneously in the year 1887 by Soltwedel in Java and Messrs. Harrison and Bovell in Barbados, British West Indies.

The young plants, when grown from seed, are very delicate and have some resemblance to ordinary grass until they reach the height of several centimeters when they begin to present the appearance of sugar-cane plants.

While many of the native varieties of cane here do not readily arrow, and, of those which do, only a small percentage of the seeds produced have so far been found to be fertile, yet during the past year a number of robust plants were produced here which unfortunately were later mistaken for grass by the workmen employed in the propagation sheds and destroyed. Plans have been made to insure the production of a large number of the seedling plants from both native and imported cane this year,

and thus varieties may be developed which may greatly increase the Philippine production of cane and sugar.

It was only two years ago that a sugar laboratory was established in connection with this Bureau, and a specialist placed in charge in order to further the work of the sugar industry and make a deeper study of the different varieties under observation. Rather than carry on strictly scientific investigations, which are nevertheless very desirable, this Bureau has in the past given its attention to the immediate assistance of planters in improving their methods of manufacture, and in establishing superior varieties of cane from abroad.

In the year 1905 this introduction of cane varieties from abroad may be said to have started. Five varieties were introduced by this Bureau in that year from the Hawaiian Sugar Planter's Experiment Station at Honolulu. The consignment contained cuttings of the following varieties; White Bamboo, Demerara 74, Singapore Striped, Tiboo Mird, and Louisiana Purple. This importation proved more or less a failure and most of the varieties perished before it was possible to learn of their results here.

In February of the year 1910 another consignment of cane was received from the Hawaiian Sugar Planters' Experiment Station and this included three cuttings from each of the following seedling varieties: Hawaii 16, 20, 27, 69, 227, 309. Plate No. II shows views of the original cuttings of these six varieties. These were carefully planted and, as soon as the new cane was large enough, they were cut while immature and planted so as to enlarge the area to such an extent that better observation might be possible as well as to have a sufficient amount of cane in order to carry on chemical analyses with the different varieties (Plate III, *b*). All six varieties were found to do extremely well under conditions here and by the year 1912 it was possible to make small shipments to various plantations in order to get the views of the planters themselves. Previous to the time that the six Hawaiian seedling varieties were received the Lahaina and Yellow Caledonia varieties were introduced from the same place.

Unfortunately the majority of the milling plants at that time were small and of antiquated designs so that difficulty was experienced in milling the large hard varieties, while some difficulty was also encountered with the soft varieties on account of their abnormal size as compared with the native varieties. There were also certain prejudices in the minds of the old local planters against the changing from the old systems, which had

been in vogue for so long a time, to modern ones, and a great deal of practical demonstration work was required to dispel this prejudice against the use of modern cane varieties. It was during this time that larger mills and centrifugal sugar factories were being introduced and with these the improved varieties became very popular. This also aided in stimulating the native planters to accept more extensively the modern varieties of cane, and especially those planters who were to supply cane to the modern factories. Each year since the introduction of these varieties the area has been greatly increased until today each sugar-producing province contains more or less of it, while on one plantation alone more than ten hectares are now under cultivation. It has been found that in many instances more than double and occasionally treble the former amount of cane is secured by the use of these varieties when it is possible to properly irrigate the land. It has been the universal custom in the Philippines to grow sugar cane without the use of irrigation, and in fact few such projects are in operation here today. The modern varieties when grown without irrigation do not produce so well and contain a notable increase in their fiber content, while on the other hand the native varieties fail to respond so readily to the application of irrigation.

Considering that only five years ago but three cuttings of each of the six Hawaiian varieties constituted the start and these were necessarily used in experimental work for some time before it was possible to begin distribution to planters, and even then demonstration work on but a small scale was possible for some time, extremely encouraging results in this direction were attained. This rapid extension of the cane area has been possible by reason of the fact that two cuttings of the crop for planting purposes each year may be made and thus the complete stalk, while yet immature, may be employed for planting under conditions here.

In October of the year 1910 cuttings of Demerara 74, 117 and 1135 were brought over from the Hawaiian Sugar Planters' Experiment Station by Mr. H. J. Gallagher, Superintendent of the La Carlota Experiment Station. The first two varieties were lost from poor germination, but the other, D-1135, survived and has proved a very good variety for certain classes of soils.

In the year 1911 a small consignment of cane was received from Mr. W. G. Taggart, Director of the Sugar Experiment Station at New Orleans, Louisiana, through the Bureau of Insular Affairs, Washington, D. C. This consignment contained the following varieties: Louisiana Striped, Louisiana Purple, Demerara 95

and 74. Since the growing season in that state never extends over a period of more than seven months, it is evident that quick-maturing canes will give the best results with them. Both the Demerara 95 and 74 are extremely early maturers, and the latter in a few years after its introduction into Louisiana became so popular that it largely replaced all other varieties previously cultivated. But this condition of early maturity is just the opposite to what is demanded in a tropical country like the Philippines where the growing season extends over the entire year. Indeed, it has been found in Hawaii that some of their best producers grow for fifteen months or more, which permits the cane to make a much better growth than would be possible in a shorter period. On account of this condition the Demerara 95 and 74 have not proved very successful here, while the Louisiana Purple likewise has always produced but a small tonnage, and has presented a stunted appearance. The Louisiana Striped, on the contrary, has done extremely well and is considered one of the very best imported varieties now in use. This cane has been characterized by a fairly low fiber content and high sucrose and purity while at the same time giving a good yield of cane. On account of the softness of its tissue, this cane has been found to be readily milled in the smaller factories. This softness of the shell, however, gave rise to certain objections some of which are not so much apparent now as they might become some time in the future, should certain insect pests and rodents be allowed to get beyond control. Soft canes are always more susceptible to insect pests, such as cane borer, than are the firmer varieties. Indeed, some of the extremely hard varieties are found to be almost immune to such attacks in countries where the insects are prevalent.

In April of 1911 the next introduction of cane was made when three four-pound parcels of the "Uba," or Japanese forage cane, were received from Chino, California. The original of this cane came to California from Prof. S. N. Tracy of Biloxi, Mississipi. This cane is not used here as a source of sugar, yet it is a closely allied species of the sugar cane. When mature, the juice contains as high as 14 per cent of sucrose, but the fiber content of the cane ranges as high as 15 per cent or more, which makes the cane impracticable as a source of sugar. The glucose ratio in the juice is also quite high, which causes the sugar to be difficult to extract. This cane is, however, used extensively as a forage crop for animals and has proved a very profitable plant for that purpose, since it requires little cultivation, stools well and ratoons almost indefinitely when a suitable soil and sufficient

moisture are provided (Plate III, *a*). It is not uncommon for this cane to produce more than 100 tons of cane per hectare each year under proper treatment and when harvested twice per year, while yet immature. This cane is green or yellowish straw in color when mature with more or less gum which gives it a blotched appearance. It is small in diameter, grows tall, and somewhat erect. The internodes are quite long, regular and contain little or no groove. The nodes are fairly prominent and set with well-developed and pointed buds. This cane germinates extremely well and even when maturity is reached very satisfactory germination often takes place. The leaves are narrow, upright, curving at about 15 centimeters from the point, and are tightly attached to the stalk even at maturity.

In the latter part of the succeeding year, 1912, Mr. H. B. Ross brought from Australia cuttings of the following varieties and presented them to this Bureau; the descriptions by Mr. Ross are given herewith:

Imperial or Striped Cheribon.—A cane distinctly striped in purple and red. The leaves are always variegated. A low-grade cane supposed to be a sport of Cheribon.

Cheribon.—Bright-red cane with long joints. A cane yielding a small per cent of sugar, but a large yield of cane per unit area. Considered a low-grade cane.

Hambledon Seedling—Queensland No. 426.—Light-purple cane, very drought resistant. Has a high sucrose content. Matures early; usually from 9 to 12 months are required. This cane was received from the Government Experiment Station at Mackay, Queensland.

Hambledon Seedling—Queensland No. 426 (Sport).—This is a long-jointed purple cane, giving a heavy yield of cane. Considered a low-grade cane.

Hambledon Seedling—Queensland No. 5.—A light-red cane very similar in appearance to Demerara 1135, but larger. Looked upon as a very satisfactory cane in Australia.

Otomato or Striped Cheribon.—An almost black cane with one purple stripe running longitudinally. Yields heavily in cane, but contains low sugar content.

Mauritius Seedling No. 1900.—This is a bright-red cane which matures early and yields well in sucrose.

Mauritius Malagache.—This is a dark-purple cane with long internodes. It matures in about 12 months. Yields exceedingly well in both sucrose and cane.

Malabar.—This cane is red to green in color; the outer tissue

cracks readily in the sun. It yields well in cane, but contains a low per cent of sugar.

Whitcaloram.—This is a dark purple or almost black cane with very long joints. When mature the outer tissue presents a sun-cracked appearance. It is a very strong cane and grows extremely erect. On this account it is sometimes used as a hedge outside of cane fields. Its sucrose content always runs low.

New Guinea No. 24.—This is a light-red cane which yields a high percentage of sugar when ripe. Care must be exercised that this cane be not cut before maturity, otherwise it dies without producing a ratoon.

New Guinea No. 24–A.—This is a light-green cane, maturing in about 12 months, and yields well.

New Guinea No. 24–B.—This is a dark-green cane with red stripes, maturing in about 12 months. It is a heavier yielder than 24–A.

Badila or New Guinea No. 15.—This cane varies from light to dark purple in color. Contains a high sucrose content. It is a late cane requiring from 12 to 15 months to mature.

New Guinea No. 40.—This is a striped cane resembling somewhat the Louisiana striped cane in appearance, except that the stripes are red and yellow of a shade similar to the Spanish National Colors. It is a late cane maturing in about 15 months and has a high sucrose content.

Barbados Seedling No. 3141.—This cane has a dark-green color and contains a high sucrose content.

The above description of varieties may not coincide exactly with the description of the same varieties now being prepared with the cane growing under the conditions and environments of this country, which sometimes make a material change in the characteristics.

During the latter part of the year 1912, the Mindoro Sugar Company imported from Hawaii a number of seedling varieties of cane and also the Striped Mexican. About the same time the seedling variety, Java 247, was received by them from Java and has since been propagated to such an extent that quite a large area is at present under cultivation on their estate. Through the courtesy of Mr. Geo. H. Fairchild, manager of that company, a consignment of the Java No. 247 cane was received by this Bureau during the latter part of the year 1913. This cane has since been growing at the Alabang experiment station and so far has given such encouraging results that it bids fair to become a popular variety here in the Philippines.

This cane varies in color from purple to a dark brown. It is very firm and resists windstorms well.

In October, 1913, two varieties, the Chinois and Big Tana, were received from Saigon. Since the original planting of this cane was so small and difficulty was experienced in starting these plants, it has not been possible to secure much data on their results here up to the present time, but during the coming year definite results will be possible since the area has now been increased to such an extent that this work may now be carried on.

The most recent importation of foreign varieties arrived in October of the present year from the sugar experiment station at Pasoeroean, Java. This consignment included the following varieties with their descriptions quoted herewith:

No. 100 P. O. J.—This is a yellow or brownish cane which does best on an aerated soil with sufficient moisture. It gives a low yield of cane but contains a high percentage of sugar. It matures quickly and is considered the second-best variety.

No. 213 P. O. J.—This is a brown-colored cane which contains a high percentage of fiber, but gives a good quality of juice. It even grows in soils which suffer from overflow and from drought.

No. 247-B.—This is a red cane now the chief variety of Java and gives a high yield of cane but contains a low percentage of sugar. It matures in Java in thirteen months.

No. 826 P. O. J.—This is a red-colored and strong cane. It is new but is considered very good.

No. 979 P. O. J.—This is a green-colored and strong cane. It is new, but is considered very good.

Black Cheribon.—This is the old cane of Java and gives a very good juice.

Unfortunately, this last consignment of cane was for some reason delayed in transit and more than three months elapsed from the time of cutting until the points were planted. On this account they were so badly deteriorated that little or no hope was entertained of any germination, but at this writing two of the varieties, No. 213 P. O. J. and Black Cheribon, are begining to show signs of growth and may possibly survive. A duplicate shipment has been requested of these varieties which, it is hoped, will arrive in good condition.

DESCRIPTION OF NATIVE VARIETIES.

Inalmon or Manila Black.—This cane has been grown to some extent in various parts of the Islands of Luzon and Negros.

It is charactized by a very dark outer tissue which distinguishes it from any other variety under cultivation here. After this dark covering has been almost entirely removed by scraping, there is enough of the soluble coloring matter (anthocyan) remaining to impart a red color to the water when the scraped stick is immersed. This cane has a very soft tissue and a fiber content ranging from 10 to 11 per cent, depending upon the conditions under which it was grown. The juice is usually high in sucrose and purity when the cane is fully mature and on account of this condition together with the fact that it has a very soft tissue and has a distinctly agreeable flavor, it has always been a favorite cane for chewing by the Filipinos. This cane grows quite rank when planted on rich moist land, but it is usually very recumbent and sometimes badly matted together at harvest time on account of its soft tissue. There is in some localities, however, a variety of this cane with marked resemblance to the one just described, except that the tissue is more firm and the cane stands more erect at maturity. It is possible that this is the same identical cane with different characteristics caused by the change in environment. The dead leaves of both of these varieties drop off as the cane ripens and leave the lower portion of the stalk quite bare.

Luzon White.—This cane varies from a greenish yellow to a straw color and is extensively grown on the low humid portions of the Island of Luzon. It does best in a rich soil with plenty of moisture, in which condition it produces a very large tonnage but does not contain a high sucrose percentage. When this cane is planted on poor soil with a scanty supply of moisture, the yield is very much diminished and the fiber content materially increased. The fiber content ordinarily runs slightly higher than in the Inalmon or Manila Black. The leaves of this cane are large, wide and usually recumbent with the leaf sheath tinted purple. This is a soft cane, and on account of this quality it has been quite popular as a cane for chewing and for use in small native mills in the regions where it has been grown.

Negros Dark Purple.—This cane bears its name from the fact that it is extensively grown in the Island of Negros which is the most important sugar-producing section of the Philippine Islands. The color varies from a light to a very dark purple, depending upon the stage of maturity and the exposure of the cane to the sun's rays.

It is a soft cane and for this reason is seldom found erect at the time of maturity, except when grown in protected localities. The fiber in this cane usually runs low, averaging from 9½ to 11

per cent at the time of maturity. The internodes are fairly long and contain a deep groove which quite often extends the full length. The concave surface of the groove is ordinarily green in color. This cane stools well when a bountiful supply of moisture is supplied and at the same time it grows much larger, but the percentage of sucrose is materially decreased, while on lands which have been cropped to sugar cane for a number of years and have not yet reached the stage of exhaustion, it produces fairly well in cane and contains a high percentage of sucrose. On the other hand, when this cane has been planted on more nearly exhausted soils, like those in the vicinity of Manila which have been grown to sugar cane ever since the introduction of the industry here, a lower yield has been obtained and the fiber content has run comparatively higher.

Cebu Light Purple.—This is a light-purple variety of cane which is grown extensively in the poor soils of the Island of Cebu and certain portions of Luzon. It does better on partly worn soils than any of the other native varieties. This cane is characterized by a very high sucrose content occasionally running beyond 17 per cent. The yield of this cane, however, is usually small in the region where it is now planted, but when grown in more fertile soils with an abundance of water, it grows larger and throws out more stalks to the stools, thus materially increasing the yield, while at the same time it contains a lower percentage of sugar. This cane is very soft and is quite popular in the regions where it is now grown, since most of the native mills are small and of such antiquated design that extraction of juice can only be accomplished with a small soft cane. The internodes of this cane are short, except when the cane is grown in good soil. The leaves are quite large, stand somewhat erect and vary from a light to a dark green color with a pinkish tinted leaf sheath.

Leyte Striped or Ambos Camarines Striped.—This cane contains stripes of red and yellow or yellowish green and resembles somewhat the Singapore Striped except that it usually grows smaller in diameter and contains longer internodes. It has never been a very popular sugar cane from the fact that it contains a low percentage of sucrose and is more difficult to mill than many of the other native varieties.

A BRIEF DESCRIPTION OF SOME OF THE FOREIGN VARIETIES GROWING IN THE PHILIPPINES.

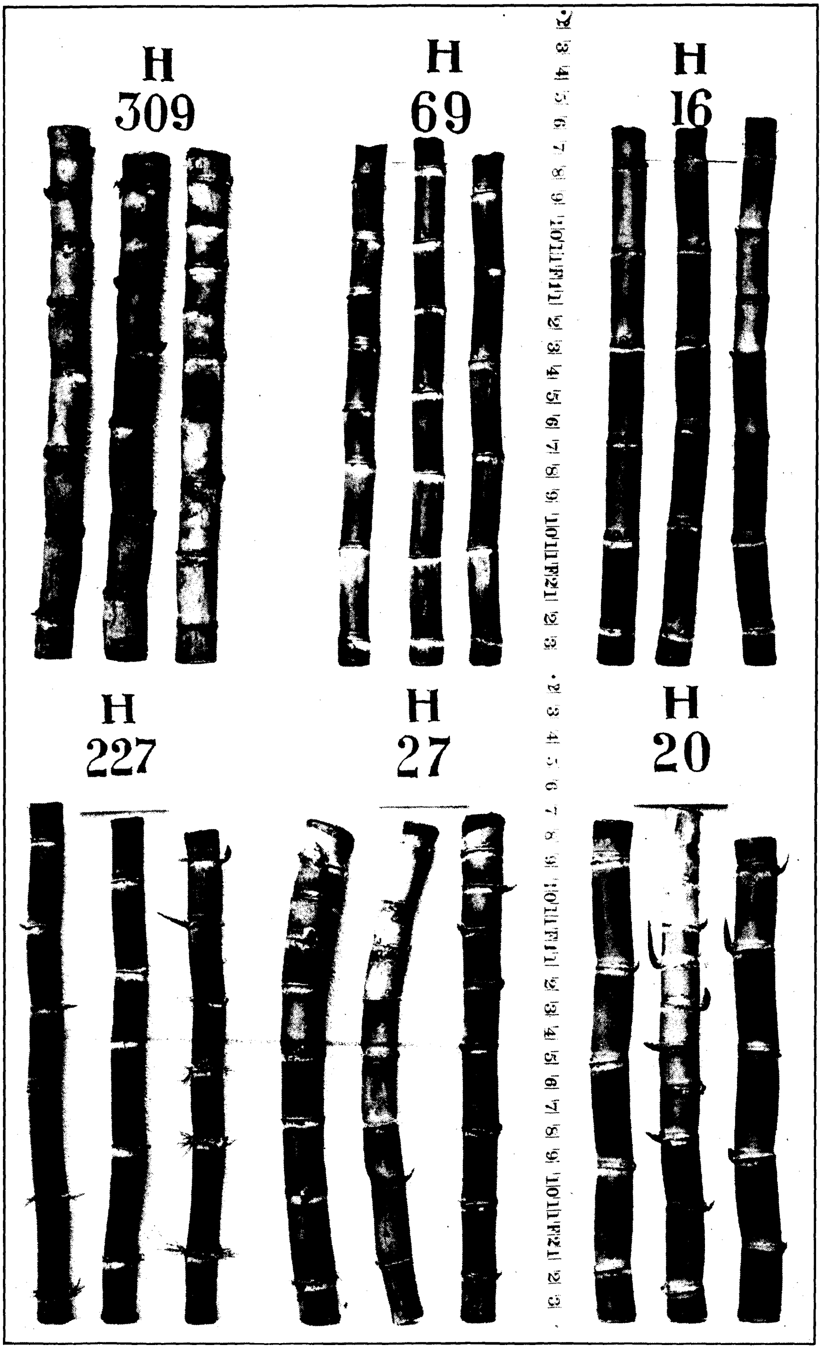
Hawaii 16.—This is a large dark-green cane with a rosy tint and a gummy appearance. It has a soft tissue and has been one of the favorite imported varieties with the native planters.

The internodes are fairly long, somewhat zigzag and contain a very slight groove. The nodes are of medium size and contain a light-colored ring where the leafsheath is attached. The buds are small and flat. The fiber content of this cane averages from 10 to 13 per cent and the juice is of a fair quality. This cane arrows profusely at the age of 11 to 12 months and contains a fairly small, spreading plume. The yield of cane and recoverable sugar is about the average for the imported varieties, this being governed largely by the condition of the soil and treatment given the cane.

Hawaii 20.—This is a light-green cane with a slightly rosy tint turning to straw color at maturity and when exposed to the sun. It is a very hard cane and grows extremely erect, resembling somewhat the yellow Caledonia except that it has longer internodes and is not so subject to splitting during rapid growth. The internodes are slightly concave and zigzag. The nodes are prominent with a pinkish tint at the ring where the leaf sheath is attached. The eyes are small and round. This cane contains from 11 to 13½ per cent of fiber and gives a juice with a fair sucrose content and purity. The yield of cane is large, and the juice is of a very good quality. This cane arrows profusely at the age of 11 or 12 months, giving a slender, fairly long plume with a long stem.

Hawaii 27.—This is a very large dark-green cane changing to a rosy tint at the upper internodes, and has a very slight gummy surface. It is but medium hard and grows erect. The internodes are fairly long and slightly zigzag. The nodes are prominent with buds which are small, yet full and round. The fiber content ranges from 11 to 13 per cent. The juice has a fair sucrose content and purity coefficient. The leaves are long and fairly erect. At the age of about twelve months this cane arrows, forming a large, open, spreading plume. This variety has given but a fair yield in cane and has not proved as favorable for the native plantations as the No. 16 and No. 69 varieties because of its fairly hard tissue.

Hawaii 69.—This is a large green cane with a rosy blush along the stalk and has a very dirty, gummy appearance. The latter characteristic is very noticeable with this variety. The tissue is soft causing the cane to be more or less recumbent. The leaves are narrow, erect and have a midrib with a greenish tint. The internodes are of average length and fairly straight. The nodes are somewhat large and set with small, flat buds which lie close to the stock. The fiber content averages from 10.5 to 13 per cent. The sucrose percentage and purity coeffi-



Original cuttings of six Hawaiian seedling varieties of sugar cane received by the Bureau of Agriculture from the Hawaiian Sugar Planters' Experiment Station in February, 1910.

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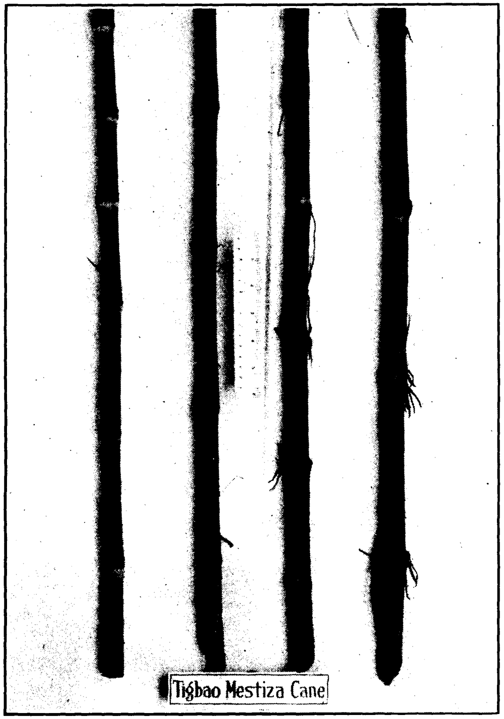
(*a*) Uba (Japanese Forage Cane) at Alabang Stock Farm. Age 10 months. November, 1914.

(*b*) Six Hawaiian seedling varieties of sugar cane growing at Alabang Stock Farm. Age 12 months. December, 1912.

PLATE IV.



(*a*) Tigbao Mestiza Cane grown at La Carlota Experiment Station. Age 12 months. December, 1915.

(*b*) Arrow (plume) of the Louisiana Striped sugar cane, grown at Alabang Stock Farm. December, 1914.

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cient of the juice have, so far, not been very encouraging, as likewise the yield of cane. It produces small, open, but spreading plumes.

Hawaii 227.—This is a fairly small straw-colored cane with a slightly rosy tint near the top and a gummy appearance all along the stalk. When exposed to the sun the main stalk often contains blotches of a blood-red color. This cane is hard and grows very tall and erect. The internodes are fairly long, slightly zigzag and contain a prominent groove. The nodes are large and set with small round buds. The leaves are narrow and stand erect, but curve near the tip. Open spreading plumes of a dull ash color form at the end of about 11 months. This cane stools fairly well and yields well in cane but the sucrose content and purity of the juice are rather low. It ranges in fiber from 11½ to 13 per cent.

Hawaii 309.—This is a very large, dark-green cane with a rosy tint on its upper portion, and a gummy appearance over the main stalk. It is fairly hard and grows quite erect. The internodes are of average length, slightly zigzag and grooved. The nodes are large, dark in color, and set with small pointed eyes. The leaves are broad and stand fairly erect, curving at about 20 centimeters from the end. This cane arrows at the age of 11 or 12 months, forming large wavy plumes. The yield of cane is above the average for the imported varieties, and it contains a juice of a very good sucrose content and purity coefficient. The content of fiber ranges from 11 to 13½ per cent.

Yellow Caledonia (Plate I).—In size this is one of the largest varieties of cane grown in these Islands. It yields better in cane than any of the other varieties when grown on rich soil with sufficient moisture and produces well even in low wet lands subject to overflow. This cane grows somewhat erect and resists windstorms well because of the hard outer tissue. The color is green, turning to yellow or straw color and, when exposed to the sunrays, a reddish appearance is taken on. The internodes are long, concave and somewhat zigzag. They often crack or split at or near the time of maturity, especially when the cane has been growing very rapidly. This condition causes a noticeable decrease in the percentage of sucrose and coefficient of purity. The nodes are large and prominent. They often contain rudimentary rootlets which have a purplish color when the leaf sheath is removed. The buds are small, flat and poorly developed. The fiber content runs from 11 to 14 per cent or even higher due to the fact that the cane often has a pithy center which contains very little juice. The leaves are long and broad with a conspicuous

white midrib. This cane arrows profusely at the age of 11 or 12 months under conditions in these Islands. The plume is of a dull gray or ash color and has large spreading branches.

Louisiana Striped.—This is a red and yellow striped variety of cane in which the colors vary to some extent according to the conditions under which it was grown. Instead of yellow the stripes are sometimes of a green color. This is more especially the case when the cane is yet immature. This variety of cane is soft and does not stand the tropical storms well. Another reason for this condition is that it grows quite tall. The internodes are long when the cane is grown in good soil. The groove is of moderate size and occasionally extends the whole length of the internodes though usually it extends but half the length. The fiber content ranges from 10½ to 13 per cent. The leaves are medium broad and quite erect. This cane arrows profusely at the age of 11 or 12 months with a fairly open but medium-sized flower (Plate IV, *b*).

Rose Bamboo.—This is a small or medium-sized cane of a green color usually having a rosy blush all along the stock. It is a medium-soft cane and for this reason is usually recumbent. The internodes are of medium length and are usually grooved the full length. The nodes are fairly large and set with small round buds. This cane arrows at the age of 11 or 12 months, giving a long spreading plume. The fiber content ranges from 11 to 13 per cent. The juice contains a fair sucrose content. This cane has never been looked upon as one of the important varieties here owing to the fact that the yield is not large.

Lahaina.—This is a medium-sized cane of a green color except when exposed to the sun, in which case it turns straw color or yellow. It is very soft and is seldom found erect at the time of harvest. The internodes are very long with a well-defined groove. The nodes are fairly large with a wide ring and often contain rudimentary rootlets showing a white ring when the leaves are removed. The buds are large and well developed. The plume is small and spreading. The fiber content of this cane ranges from 10½ to 12½ per cent. It gives a juice of a high percentage of sucrose and coefficient of purity, but the yield in cane has been slightly below the average of the imported varieties.

The above description of cane varieties is based on observations taken here in the Philippine Islands in which climatic conditions are such that cane reaches maturity at the end of 12 months when planted just after the close of the rainy season. When cane is

planted late in the season, it occasionally happens that those varieties which ordinarily arrow, fail to do so under prevailing conditions and fail to reach a natural state of maturity, hence, they contain a greater percentage of fiber and give a juice with a lower sucrose percentage and purity coefficient.

The "Louisiana Striped" variety when grown under conditions here in these Islands produces, at the end of one year, a fairly open but medium-sized plume of a dull-ash color. The sucrose content of the cane and purity coefficient of the juice are each very satisfactory yet when grown in Louisiana this cane never arrows and contains a much inferior juice. This is, of course, due to the fact that cane reaches full maturity here, while there it is never permitted to grow more than seven months on account of the cooler climate.

FIELD AND LABORATORY TRIALS.

To obtain comparative results on the different varieties under observation, a level tract of land of uniform composition was secured at the La Carlota experiment station in Occidental Negros late in 1912. It was prepared and planted to the different varieties under strictly uniform conditions. The cane was cut into lengths containing two or three good buds each and only the upper or immature portion of the stalk was used for this purpose. The rows were placed $1\frac{1}{2}$ meters apart and the cane planted three points to the meter, being set at an angle of about 45 degrees from horizontal. As sugar cane matures in about 12 months in the Philippines, this cane was ready for cutting in the following December and January, these being the months in which the cane harvest usually begins.

In carrying on investigation work with the different varieties, a large sample consisting of average stalks is collected once each week and immediately analyzed. The juice is extracted by means of a laboratory mill, giving an average extraction of 67 per cent of the weight of the cane. The fiber is determined by the hot-water diffusion process in which a temperature of 80° to 100° C. is reached before each expulsion. After five extractions the fiber is dried to constant weight.

The total solids of the juice are determined by Brix spindles carefully calibrated at $27\frac{1}{2}$° C., that being the standard temperature for tropical countries. In order to give results in a tabulated form which would be comparative with those obtained from the several factories scattered over the different sugar regions, direct polariscopic readings, using Horne's dry-lead subacitate

as a precipitate, have been employed. For other purposes the Clerget or invert-reading method has been employed, using the following formula to compute the results:

$$S=\frac{100\ (P-I)}{142.66-\frac{T}{2}}$$

Glucose is determined by the volumetric method using Soxhlet's solution.

Analytical work on the cane varieties is started about one month before the opening of the milling season and is continued to about one month beyond the close of that season. This usually is from November to March. A tabulated list of some of the more promising varieties of cane now under observation is included at the close of this article and a description of these cane varieties is given on the preceding pages.

SELECTION OF CANE VARIETIES MOST PROFITABLE TO CULTIVATE.

In the selection of the most profitable cane variety to be cultivated a great many factors must be taken into consideration. Among them may be mentioned the sucrose content of the cane, purity of the juice, fiber content of the cane, the yield of the cane, and the yield of available sugar. This latter factor is one of the most important to the sugar producer as it shows the amount of the finished product to be obtained. A very convenient formula for computing the available sugar from the extracted juice is as follows:

$$\left.\begin{matrix}\text{Weight of total sol-}\\\text{ids in the juice.}\end{matrix}\right\}\times 100-\left\{\frac{100-\text{Purity of juice}}{100-\text{Purity of exhausted molasses.}}\right\}=\begin{matrix}\text{Available}\\\text{sucrose.}\end{matrix}$$

Ordinarily when cane is to be milled in a large modern factory the hard varieties answer as well as the soft from the extraction standpoint. Therefore this point need not cause any concern. These hard canes have a distinct advantage over the softer ones in regions where such insects as cane borers are prevalent, or where damage by rodents occurs, since they offer more or less resistance to these attacks. There is also less labor required in harvesting such varieties since they stand more erect and do not become so tangled and twisted during storms. On the other hand, where the crushing plants are small and imperfect, it is impossible to secure a good extraction with these varieties and consequently in that case the softer varieties answer better.

Average analyses of cane juices from varieties growing at the La Carlota experiment station, Occidental Negros, 1914–1915.

(Extraction juice on cane 67 per cent.)

Month.	Weight of stalk in kilos.	Brix.	Sucrose.	Purity.	Glucose.
Hawaii 16:					
October	1.90	14.80	11.48	77.56	1.370
November	1.37	15.45	12.70	81.98	1.005
December	1.40	16.47	14.25	86.52	0.680
January	1.58	15.68	13.36	85.20	0.660
February	1.49	15.77	14.10	89.41	0.510
March	1.75	13.55	11.38	83.98	0.500
April	1.75	17.45	15.37	88.08	0.610
Hawaii 20:					
October	1.77	16.70	13.98	83.71	0.806
November	1.48	18.90	16.35	86.50	0.640
December	1.83	18.40	15.95	86.68	0.580
January	1.61	16.66	14.40	86.43	0.476
February	1.43	14.80	13.35	90.20	0.500
March	1.44	14.80	12.20	82.43	0.660
April	1.38	16.85	14.50	86.05	0.420
Hawaii 27:					
October	2.09	15.30	12.02	78.56	1.070
November	1.87	17.05	14.10	82.69	0.720
December	1.25	16.20	13.45	83.02	0.730
January	1.73	17.16	14.50	84.49	0.550
February	1.81	17.40	14.90	85.63	0.480
March	2.21	17.97	15.25	84.86	0.630
April	2.15	19.55	17.12	87.57	0.400
Hawaii 69:					
October	1.64	15.30	11.95	78.10	0.860
November	1.32	16.60	13.40	80.72	0.670
December	1.23	15.30	12.30	80.39	0.785
January	1.39	15.32	12.10	78.98	0.690
February	1.26	15.10	11.95	79.13	0.657
March	1.62	16.55	12.97	78.36	0.580
April	1.48	16.10	13.07	81.18	0.245
Hawaii 227:					
October	1.61	15.86	12.34	77.17	0.950
November	1.53	17.37	14.40	83.47	0.717
December	1.16	17.00	11.20	65.88	0.660
January	1.38	16.90	14.20	84.02	0.440
February	1.40	17.37	14.90	85.78	0.470
March	1.61	17.70	14.90	84.18	0.510
April	1.44	18.45	15.67	84.71	0.410
Hawaii 309:					
October	2.35	16.57	13.68	82.55	0.886
November	2.14	17.67	15.05	85.11	0.75
December	1.94	17.07	14.35	84.06	0.62
January	2.20	17.45	15.20	87.10	0.45
February	1.79	17.70	16.35	92.37	0.43
March	2.00	18.50	15.15	81.89	0.40
April	2.33	17.60	15.42	87.73	0.35
Yellow Caledonia:					
October	2.00	15.44	11.70	75.77	1.210
November	1.83	16.70	13.65	81.73	0.810
December	1.26	16.35	13.25	81.03	0.730
January	1.53	17.10	13.85	80.99	0.620
February	1.36	18.40	15.47	84.07	0.510
March	------	------	------	------	------
April	1.41	16.57	13.12	79.17	0.510
Louisiana Striped:					
October	1.53	17.08	14.24	83.37	0.920
November	1.25	18.70	16.40	87.70	0.468
December	1.32	18.82	16.80	89.26	0.370
January	1.42	18.90	16.88	89.31	0.398
February	1.23	19.95	16.70	83.70	0.400
March	1.20	19.75	17.17	86.93	0.690
April	1.25	20.07	17.90	89.18	0.440
Rose Bamboo:					
October	1.46	16.48	14.00	84.95	0.740
November	1.47	17.20	14.20	82.55	0.510
December	1.15	15.90	14.80	93.08	0.540
January	1.46	16.30	14.00	85.88	0.410
February	1.50	16.37	14.50	88.57	0.420
March	------	------	------	------	------
April	1.41	19.05	17.37	91.18	0.260

Average analyses of cane juices from varieties growing at the La Carlota experiment station, Occidental Negros, 1914–1915—Continued.

Month.	Weight of stalk in kilos.	Brix.	Sucrose.	Purity.	Glucose.
Formosa:					
October	1.42	16.58	13.20	79.61	0.860
November	1.56	18.70	16.00	85.56	0.647
December	1.90	17.20	14.80	86.04	0.480
January	1.42	16.90	14.58	86.27	0.500
February	1.54	18.45	16.50	89.43	0.380
March	1.50	19.75	17.90	90.63	0.570
April	1.51	18.82	16.47	87.51	0.260
Chinoise 3526:					
October	1.26	16.70	14.20	85.02	0.570
November	1.10	16.90	14.50	85.79	0.557
December	1.54	15.88	12.90	81.23	0.880
January	1.30	19.40	17.00	87.62	0.190
February	1.26	19.60	14.74	75.20	0.210
March					
April	1.05	21.15	18.70	88.41	0.240
Louisiana Purple:					
October	1.54	15.88	12.90	81.23	0.886
November	1.10	16.90	14.50	85.79	0.557
December	1.26	16.70	14.20	85.02	0.570
January	1.20	16.20	12.40	76.54	0.487
February					
Lahaina:					
October	1.73	19.10	16.87	88.32	0.420
November	1.32	19.67	17.45	88.71	0.345
December	1.37	19.47	17.54	90.08	0.217
January	1.27	17.78	15.68	88.18	0.338
February	1.40	18.07	17.07	94.46	0.260
March	1.31	18.07	16.7	92.41	0.400
April	1.40	20.22	18.57	91.83	0.260
Inalmon or Manila Black:					
October	1.58	17.40	15.04	86.43	0.730
November	1.39	18.70	16.50	88.24	0.405
December	1.07	18.45	16.67	90.35	0.315
January	1.33	17.23	15.50	89.69	0.368
February	1.38	17.85	15.82	88.62	0.407
March	1.49	16.47	13.85	84.09	0.620
April	1.56	18.97	17.10	90.14	0.230
Negros Purple:					
October	1.19	16.04	13.10	81.67	0.998
November	1.04	17.87	15.60	87.29	0.470
December	1.06	19.35	17.60	90.95	0.270
January	1.23	18.20	16.08	88.35	0.390
February	1.28	19.60	17.57	89.64	0.480
March	1.29	18.90	16.86	80.20	0.560
April	1.42	20.10	17.40	86.56	0.400
Cebú Light Purple:					
October	1.32	13.88	10.60	76.36	1.290
November	1.15	15.55	12.80	82.31	0.760
December	1.12	17.50	15.80	90.28	0.530
January	1.37	18.80	16.68	88.72	0.380
February	1.28	10.80	17.60	89.79	0.280
March		20.47	18.15	88.66	
April	1.60	18.45	16.10	87.26	0.310
Luzon White:					
October	1.50	16.10	13.70	85.09	0.720
November	1.22	17.02	14.70	86.36	0.530
December	1.20	17.35	15.50	89.33	0.308
January	1.20	17.68	14.60	82.57	0.280
February	1.35	18.65	16.30	87.39	0.250
March		18.97	17.00	89.61	
April	1.35	18.92	16.72	88.37	0.390

The above represent an average of composite samples taken each week during the respective month.

A FEW FACTORS IN INSECT CONTROL.

By JOHN T. ZIMMER, *Acting Superintendent of Pest Control.*

Insects may be divided into the following three general groups, according to their relationship with man: beneficial, neutral, and injurious.

The first group includes those forms which are of service to man either directly, such as the cochineal insect, the silkworm moth or the honey bee which furnish products useful to man, or more indirectly, such as the various wild bees, moths, beetles and other forms which pollinate flowers and aid in the production of fruit, such as the scavengers which destroy rotting material which might otherwise spread disease, and the parasites and predators which, in common with man, wage warfare against the pests.

The neutral insects are those which devote their attention to plant and animal forms which man does not find either serviceable or injurious and with the development of which he is not interested except in a purely scientific sense.

The injurious insects are those which by their depredations cause economic losses to man. These depredations are widespread, and may be upon field crops, upon economic products such as cigars, furniture or woodwork of other kinds, upon growing timber, or upon man himself, either as a direct parasite or as a carrier of disease. The depredations may be in the nature of secondary parasitism, that is, attacks upon forms which as primary parasites are attacking other insects and which in this particular case are helping in the control of pests.

None of these groups are stable. Insects which may be beneficial in one stage of their existence may be injurious in another. For instance, certain of the blister-beetles found in America feed as larvæ upon locust eggs, but when they themselves reach adult development they turn their attention to alfalfa and cause severe injury thereto. Other species may be injurious only under certain conditions as, for example, the rice bug of this country which feeds normally upon various wild grasses but

attacks rice when the latter is grown in regions inhabited by the bug. Certain predatory insects feed alike on injurious, neutral, and beneficial forms and automatically become beneficial, neutral or injurious accordingly, depending on the preponderance of activity.

Nevertheless, certain insects have very definite tendencies and occupy a fairly constant position which is very readily determinable, either as friends or enemies. Those which are enemies are, perhaps, better known to the average farmer than those which are friends, but although he must learn to recognize the beneficial forms and protect them he must also learn to distinguish the enemies and find out how to combat them.

A certain amount of insect damage is purely mechanical, such as the breaking down of bamboos and standing grain by locusts which settle upon them. A certain portion is also connected with the breeding habits of the creatures, such as the slitting of twigs of trees by cicadas to form receptacles for egg deposits, the girdling of stems by twig pruners so that the larvæ of the pest may have suitable places to work when they hatch, or the mutilation of leaves by certain ants and bees in their search for building materials for their nests. Nevertheless, the greater amount of destruction is the direct result of the insects feeding or searching for food.

Setting aside the exceptions here mentioned we may subdivide the insect pests into two general groups based on the manner in which their food is obtained, in other words, on the character of the anatomy of the mouth parts. Aside from a few cases where the adults have atrophied mouth parts and take no food after they become imagoes, such as the Mayflies and bot flies, insects have mouth parts fitted for biting or for sucking. One type may be present in the larvæ and the other in the adults of a single species as in the butterflies and moths, or they may be combined in one as in the bees. The forms with jaws usually procure their food by removing particles of the plant and either chewing and swallowing these pieces or squeezing them between their jaws and swallowing the juice. A notable example of the latter is found in the adult of the common uang or rhinoceros beetle which attacks the coconut trees. The forms which have sucking mouth parts may sip exudations as do the butterflies and moths, in which case they are scarcely injurious; they may, as do the maggots of certain flies, attach themselves to the host and absorb the juices through the surface; or they may, as do the plant lice and scale insects, force their beaks beneath the surface and suck their food therefrom without ab-

sorbing any surface particles. This is a feature which is of extreme importance when it comes to the matter of applying poisons to control insect attacks.

There is no part of a plant that is safe from the ravages of pests—roots, trunks or stems, branches, foliage, flowers or fruit, pith, bark or heartwood; all may be affected and by insects with either suctorial or mandibulate mouth parts. Some of the pests may be external feeders living on the surface of their host plants, feeding entirely on surface matter or sometimes boring short distances into the interior as in the case of the rhinoceros beetle or as in the curculios and bill bugs, whose attack resembles somewhat that of the sucking insects. Some of them may be true borers, passing at least one stage of their existence wholly within the interior of the plant they infest. These latter sorts include the particular forms which bore between the surfaces of leaves and which are known by the distinctive term "leaf-miners." The borers are all more difficult to attack than the purely external feeders since they are often inaccessible unless the plants or parts of the plants have first been destroyed. Likewise the sucking insects offer difficulties due to the fact that their food cannot be poisoned in such a way that they will eat the treated portions. Spraying for these pests must be done by applying washes or solutions which operate caustically or poisonously upon the integument or in the tracheæ of the insects with which they come in direct contact. Frequently the insects which it is thus desired to attack are of such constitution that any spray which is strong enough to have the desired effect on them will seriously injure the plants on which they are feeding. Thus, in many cases, unless the pest is present in small isolated groups which may be profitably destroyed along with their host plants to the end that the remainder of the fields may be safe from attack, spraying with "contact poisons" is quite out of the question.

Means of control of insect pests may be roughly classified as insecticidal or preventive. The insecticidal treatments embrace those types which result in the death of the pests; preventive, those which avert insect attack either by driving the pests away when they make their appearance, or by making their hosts inaccessible or distasteful to them.

As roughly classified, we may include natural enemies among the insecticides. These are parasites, predaceous animals, diseases, and those mechanical forms of control such as hand picking or collecting, trapping, exposing to the action of weather or to extremes of temperature, inundation, etc. More partic-

ularly the term is restricted to the application of artificial remedial measures such as poisons or corrosive mixtures, or fumigants. The poisons may be applied directly to the food plants of the insects, coating these in such a way that in order to obtain food the creatures must absorb some of the poison into their systems. The poisons must therefore be applied in strengths which not only will have no injurious effect on the plants but will not be so distasteful to the pests that the latter will refuse to eat the treated material. Yet the insecticide must kill the pests or render them helpless when they do eat it. In other cases these "stomach poisons," as they are called, may be used to poison baits which are offered to the pests and which are made so attractive by one means and another that the insects prefer them to, or find them more readily than the crops they are about to attack, discontinue their depredations and turn their attention to the poisoned material.

In one sense the planting of trap crops belongs in this group of treatments; in another sense it should be classed with the preventives. Very frequently when some particularly early-maturing varieties of a crop are grown, the pests turn their attention to them while the later varieties are coming on. As a result, this concentrated attack may seriously injure these earlier fields where if the attack were spread out over the larger extent of ordinary varieties it would not be so noticeable. If the earlier varieties alone were grown the result would be the same as if all were grown later, so far as diffusion of attack is concerned, unless the species of pest habitually disappears before the regular crop comes on and this crop, then, escapes by reason of its later maturity. However, this circumstance is frequently made of use and where the normally maturing crops are grown, it is possible to trap the plant enemies by setting out a small plot early. The pests are thus concentrated on this small area which may then be entirely destroyed along with the pests before the time when the harvest crop would be subject to attack.

There are probably few insects which do not have one or more natural enemies, and this explains why the majority of insect forms never make their presence felt by the severity of their depredations because their natural enemies keep them so well under control. This is a fortunate fact. Insects are sometimes exceedingly prolific. The female "anay" has been known to lay eggs at the rate of one per second, sixty to the minute, which gives a possibility of eighty-six thousand four hundred per day, since the queen lays continously when once she begins.

Another striking illustration is found in the plant lice or aphids. Under certain conditions these produce young alive, each one of which may, when grown, give birth to others without any fertilization or oviposition being necessary. The rate of production may be 8 per day, not high when compared with the "anay," but in five days the adult stage may be reached and each of the 8 produce 8 more. Taking this as continuous, as it may easily be, and supposing that no natural checks operate to destroy any of the insects, supposing even that each louse produces only 8 others (one day's production), at the end of two months the number of aphids descended from a single stem-mother will be over seventy-eight billion, five hundred million, enough, allowing each insect two millimeters of length, if placed "head to tail," to cover a distance of over seventy-eight thousand, five hundred kilometers. When it is considered that the reproduction of each adult louse is not confined to one day but goes on for a number of days, the possibilities thus opened are startling.

This enormous rate of increase is necessary to these soft-bodied insects as they are not capable of much self defense and their enemies would otherwise quickly annihilate them. As it is, some of them never become serious pests and this is also true with many other species which do not increase so rapidly.

Many sporadic outbreaks are caused by a sudden decrease in the number of parasites and predators which prey on the pest in question. Usually this increase produces such an abundance of food for the parasites and predators that they, too, are soon able to increase accordingly and again regain the upper hand.

When, however, man introduces some plant pest into a new region without its accompanying enemies, the pest may soon increase beyond the bounds of safety and the farmer suffer in consequence. It has been possible in some instances to introduce the natural enemies of the pest and so bring the latter under control, but this does not always work out in actual practice. When man destroys the insectivorous birds, even though they may be doing a small amount of damage to his crop, he is reducing the number of allies which can do far more than he to keep down more serious plagues. Often in cultivating ground, man destroys unconsciously the retreats of predaceous foes to crop pests, but as this cannot be well helped it must be counteracted by more assiduous work in other directions. Fortunately some pests are also destroyed by the same operation. Absolute bird protection, until it is actually proven that certain birds are more injurious than beneficial, is one of the best insecticidal methods that can be followed.

Some parasites prey upon other parasites, which in turn attack still others and these yet more, the primary parasites perhaps attacking the foe of some plant while the tertiary or quaternary parasite is in turn preyed upon by some predaceous enemy which may be itself parasitized. This question of parasitism and hyperparasitism has long been studied and is of exceptional interest. It has a practical value in more ways than one. The agriculturist should bear in mind that the fact that certain insects are noted to be exceedingly abundant in a certain field should not be taken as conclusive proof that those insects are the cause of any damage to the plants. They may be the controlling factor with respect to the real pest.

Practically speaking, too much reliance should not be placed in the idea of controlling widespread pests by means of introduced parasites. It is true that in some cases this has worked out satisfactorily, and it is also true that it can be made to work in other instances, but when the prevalence of a pest is due to the change of conditions which man has brought about, absolute relief may be sought only in the reëstablishment of the balance of nature which in its theoretically perfect condition keeps all forms of life from undue increase and within normal bounds although it does not totally destroy any entire group. Sometimes the normal bounds are not the bounds of neutrality or else normal conditions are undesirable and recourse must accordingly be sought in measures operated by man himself.

Preventive measures may be taken to mean the dust sprays, the smudges, the insect powders such as pyrethrum, and the various types of "scare-crows" that are often used and which tend by their presence to direct the attack of the pests to other situations not thus protected. They include the ditches dug around fields to keep swarming caterpillars and grasshoppers from entering, the tarred bands around tree trunks to keep certain insects from ascending to the foliage, the pans of water by means of which furniture is protected from the ingress of ants, the whitewashes and sacking placed on trees to keep the borers from getting to the bark, and the screens and mosquito bars on houses and beds to keep out flies and mosquitoes. They may also be considered as including the various forms of farm practice which tend to make the attacks of the pests less effective, such as the fertilizing of weak soils, the cultivation of resistent stocks and the general cultural methods which neutralize insect attack and some of which also cause a certain amount of mortality among the plagues as do early or late planting, seasonal plowing, and the like.

Perhaps the most important measures, at least to the agriculturist, are the practice of clean culture, the betterment of agricultural methods, and the improvement of crops. Insects of many kinds love rubbish. They breed in such places in countless numbers, they hibernate in them, they live in them. When such places are kept cleaned up and weed patches are given attention regularly, it will be found that the number of insects present in the fields decreases materially. Some forms of pests may be entirely controlled in this manner if the work is thoroughly done. Certain crops, when it is not possible to destroy the insects present upon them, may be developed to such a healthy, hardy condition that the attacks of the pests do not reduce the vitality of the plants below a point where the harvest may still be profitable. If the insects are capable of being destroyed the advantage is of course all the more marked. It should be remembered that the hardier a plant is, the better can it withstand pest attack, permit severe remedial measures to be performed on it if necessary or the better can it recover from damage which may be inflicted upon it. Therefore, if practices are followed which bear out these principles, the work of pest extermination by artificial means, when it becomes necessary, is materially reduced and the effect of such work increased.

HYBRIDIZATION OF ANNONAS.

By P. J. Wester, *Horticulturist in Charge of Lamao Experiment Station.*

Experiments in Annona hybridization were begun by the writer in 1908 at the Subtropical Garden, Miami, Florida, and continued during 1909 and 1910, an account of which was published in the Bulletin of the Torrey Botanical Club, Vol. 37 (1910), pp. 529–539. When the writer accepted his present position he brought with him to the Philippines in 1911 a few seeds, the result of a cross between the sugarapple (*Annona squamosa*), the mother plant, and the cherimoya (*A. cherimolia*), from which 24 plants were raised and planted out at the Lamao experiment station. One of these hybrids, No. 4, ripened one fruit in 1913, which was described in The Philippine Agricultural Review, Volume VII (1914), No. 2, page 70, and the hybrids were named atemoyas to distinguish them from other annonaceous fruits. In 1914, nineteen more hybrids bore from 1 to 46 fruits each, or 203 fruits in all.

As the plants came into bloom quite a number of crosses were made between the atemoya seedlings and other annonas, as follows: three between the sugarapple and the atemoya, sixteen between the custardapple and the atemoya, ten between the "Giant" cherimoya from Australia and the atemoya, and 23 between the mamon (*Annona glabra*) and the atemoya. In practically all cases fruits of greater or less size resulted. It is perhaps worthy of note that in every instance where mamon pollen was employed the pulp was lumpy and the quality of the fruit was defective. The seeds in these fruits were also very largely defective, and of those that appeared to be fertile and were planted not one has germinated.

In order to insure the setting of a large number of fruits on the hybrid seedlings many flowers were hand pollinated, and most of the fruits were unquestionably produced thereby. The resultant fruits are consequently no indication of the productivity of the trees under ordinary conditions. Pollinating *Coleoptera* were present in very small numbers on the atemoyas as com-

pared with the custardapple and sugarapple. The pollinations were begun March 20, 1914, and concluded April 8; the earliest fruit ripened June 30, and the last was picked August 1. Nearly all matured during the rainy period.

The atemoya plants (Plate V, *b*), of which there are 24, all grown from seed from one fruit, greatly surpass the parents in vigor, and are very similar in habit, stems, leaves and flowers to the cherimoya. In fact the only trace of the mother parent is found in the absence of the velvety under surface of the leaves which characterizes the cherimoya. With respect to the parent variety of cherimoya the leaves of the progeny are frequently twice as large as in those of the parent, and they have inherited the elongated shape of the leaf of the sugarapple (Plate X, *a*, *b*, *d*) being 16 to 22 centimeters long and 8 to 12 centimeters broad. The flowers are indistinguishable from those of the cherimoya (Plate IX, *a*,), and like that species the atemoya sheds the pollen in the afternoon.

Exteriorally the fruits have exhibited greater variation than any other part of the plant; No. 4, which fruited in 1913 and was described in the Review last year, most closely approached the cherimoya in quality. In the fruits of those seedlings that fruited in 1914, the cherimoya flavor was more or less apparent in six hybrids, the rest not having any distinctive cherimoya flavor; in quality, no one was inferior to, and a number were distinct improvements upon, the sugarapple.

Fruits weighing less than 100 grams have been considered as culls and have not been included in making the descriptions or in computing the average weight of the fruit of a hybrid. Generally speaking, the small size of the fruits has been a disappointment, though it should be recorded that the parent cherimoya was not much larger than an ordinary sugarapple. (Plate VI.) It is perhaps also worthy of notice that some of the fruits on one plant were more than twice as large as either parent (Plates VI, *c*, VII, *d*). In this connection it may be said that the average sugarapple weighs 200 to 250 grams. An annonaceous fruit of this weight is of about the right size for a dessert fruit of this kind served singly. Large annonaceous fruits are preferable to smaller ones principally because the seeds then become less objectionable than in a smaller fruit; the flavor and quality in a large fruit are also somewhat enhanced. All descriptions are made from fruits ripening in 1914.

The following is a description of the fruits:

No. 2. Weight 150 to 225 grams; length 70 to 72 millimeters; width 60 to 75 millimeters; shape cordiform; areoles distinct; carpels more or

less prominent, ending mostly in an acute dark-green, corrugate point; carpellar surface green with white bloom, area along areolar lines cream colored; skin medium thick, rather brittle; pulp white, juicy, melting and sweet, with trace of acid, and pronounced aroma and flavor of cherimoya.

No. 2 yielded three fruits of which two were produced through a cross with the mamon, and one by a cross with the sugarapple. The description of the flesh is made from this latter fruit, the flesh of the other two being more or less defective.

No. 3. Size very small, 100 to 145 grams in weight; length 58 millimeters; width 55 millimeters; shape more or less irregularly cordiform; carpels equal, to more or less raised, light green, frequently dark green and corrugate at stigmatic point; areoles distinct; skin variable in thickness and toughness; bloom white; pulp white, juicy, sweet, almost watery, faintly aromatic, devoid of cherimoya flavor; quality good, about equal to a good sugarapple.

This tree bore 12 fruits of which only 2 weighed above 100 grams, and the small size and the lack of distinct qualities eliminates it as a desirable fruit.

No. 5. (Plate VIII, *b*.) Weight 130 to 235 grams; length 54 to 65 millimeters; transverse diameter 58 to 72 millimeters; shape regularly cordiform, sometimes broader than long; carpels a trifle depressed, equal to slightly raised towards base; areoles distinct; surface smooth, greenish with red dots on sun-exposed side; bloom white; skin medium thick and fairly tough; flesh white, juicy, without objectionable fiber, sweet, with a trace of acidity and a suggestion of cherimoya flavor.

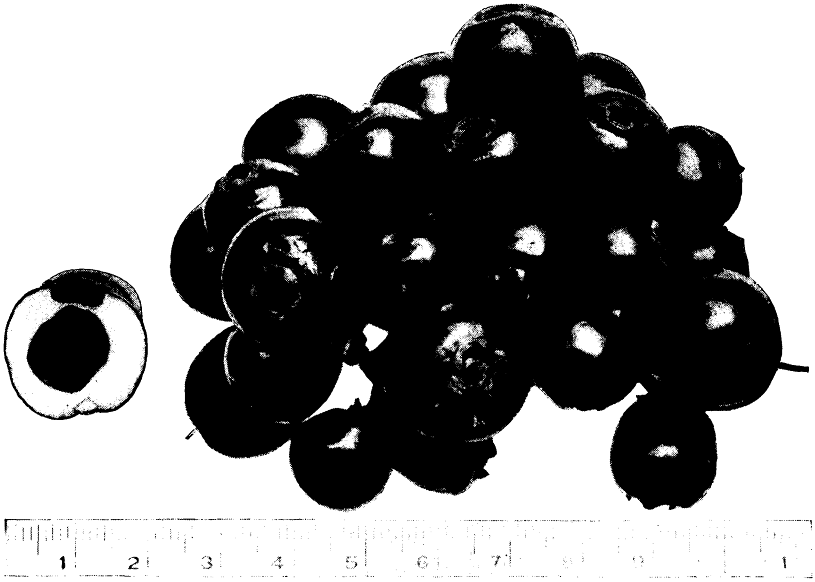
Of thirteen fruits on this plant nine weighed above 100 grams. In attractive appearance they surpassed all fruits on the sister hybrids, and were markedly superior in quality to the sugarapple.

No. 6. Weight 115 to 250 grams; length 57 to 84 millimeters; diameter 52 to 75 millimeters; shape cordiform; carpels usually depressed or equal on apical half and raised towards base; areoles distinct; surface greenish with white bloom; skin quite thick and tough; pulp white, with scarcely noticeable fiber, juicy, sweet, of good flavor, with little or no trace of the cherimoya flavor, faintly aromatic.

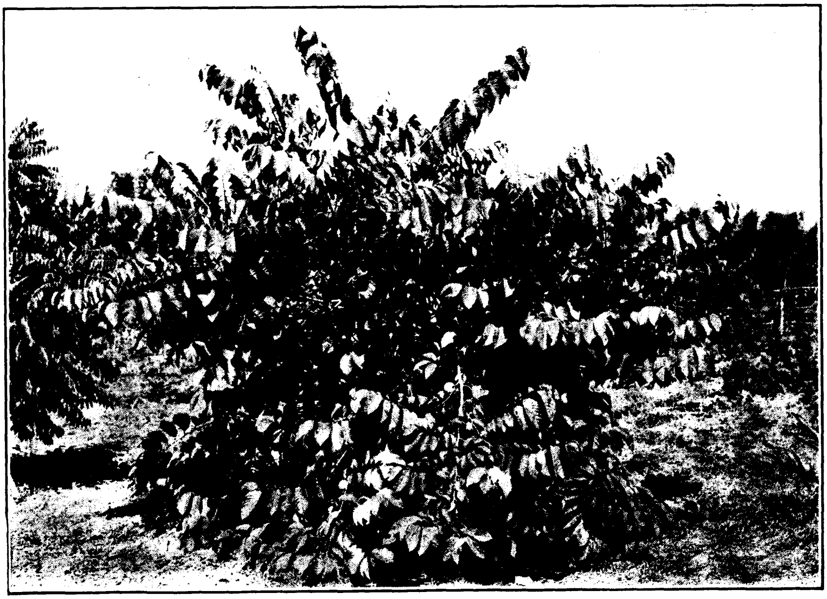
Fourteen fruits out of twenty-seven weighed more than 100 grams, of which three exceeded 200 grams. In quality No. 6 compares favorably with a good sugarapple.

No. 7. Weight 145 to 190 grams; length 60 to 65 millimeters; transverse diameter 60 to 63 millimeters; shape regularly cordiform; carpels equal to a trifle raised; areoles distinct; skin thin, but quite tough; pulp white, with weak, unobjectionable fiber, sweet, juicy, faintly aromatic, cherimoya flavor absent.

This tree carried three fruits of which two weighed above 100 grams; about equal to or a little better in quality than the sugarapple.



(*a*) A bunch of fruit of the lipoti, *Eugenia curranii* C. B. R.



(*b*) Atemoya tree in fruit; age of tree three years. Lamao Experiment Station. 1914.

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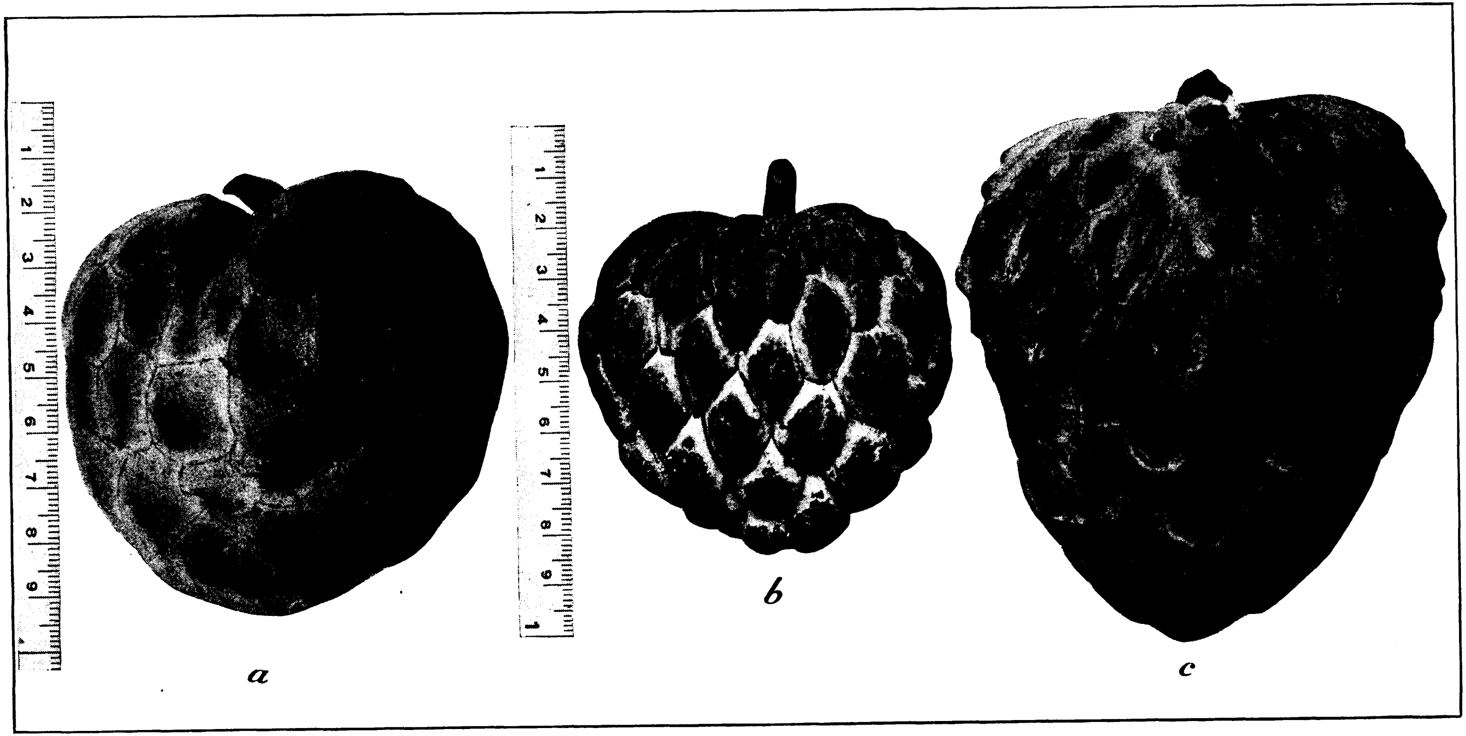
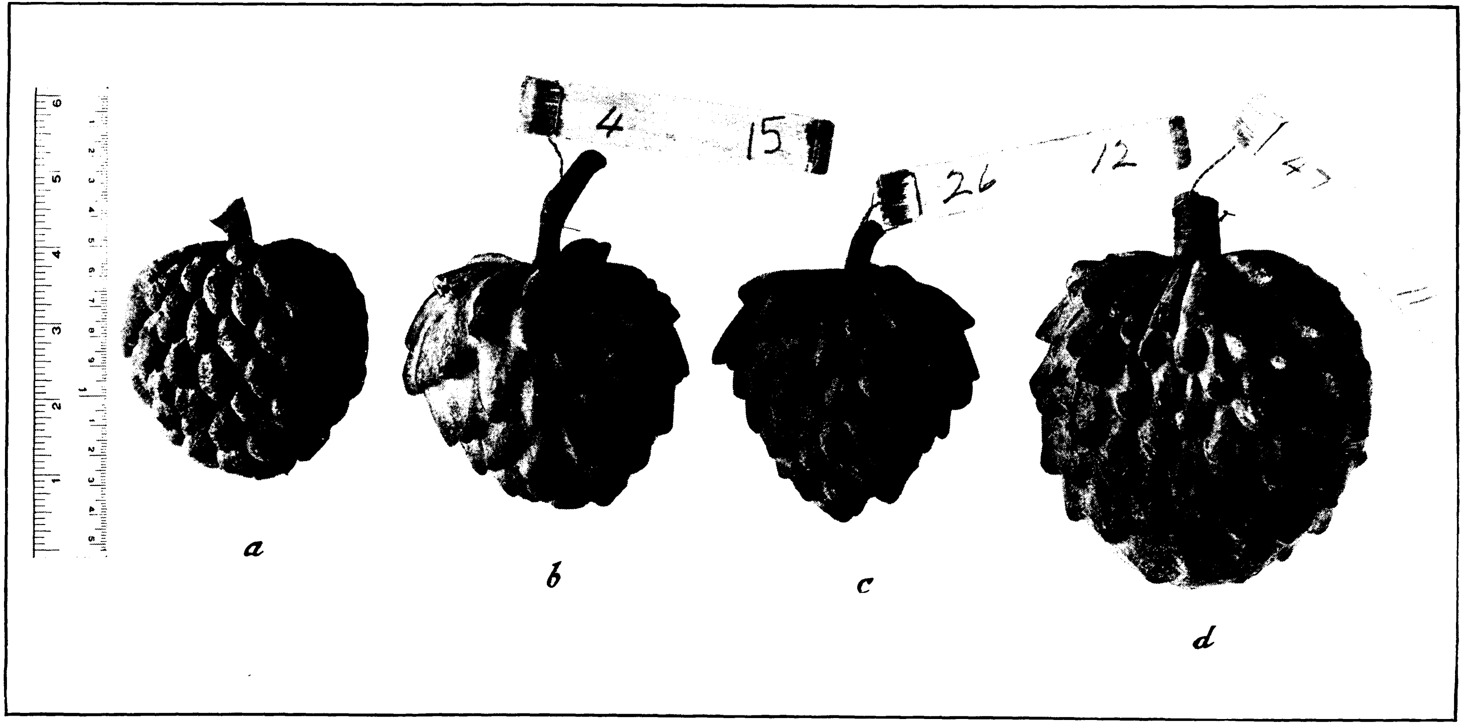
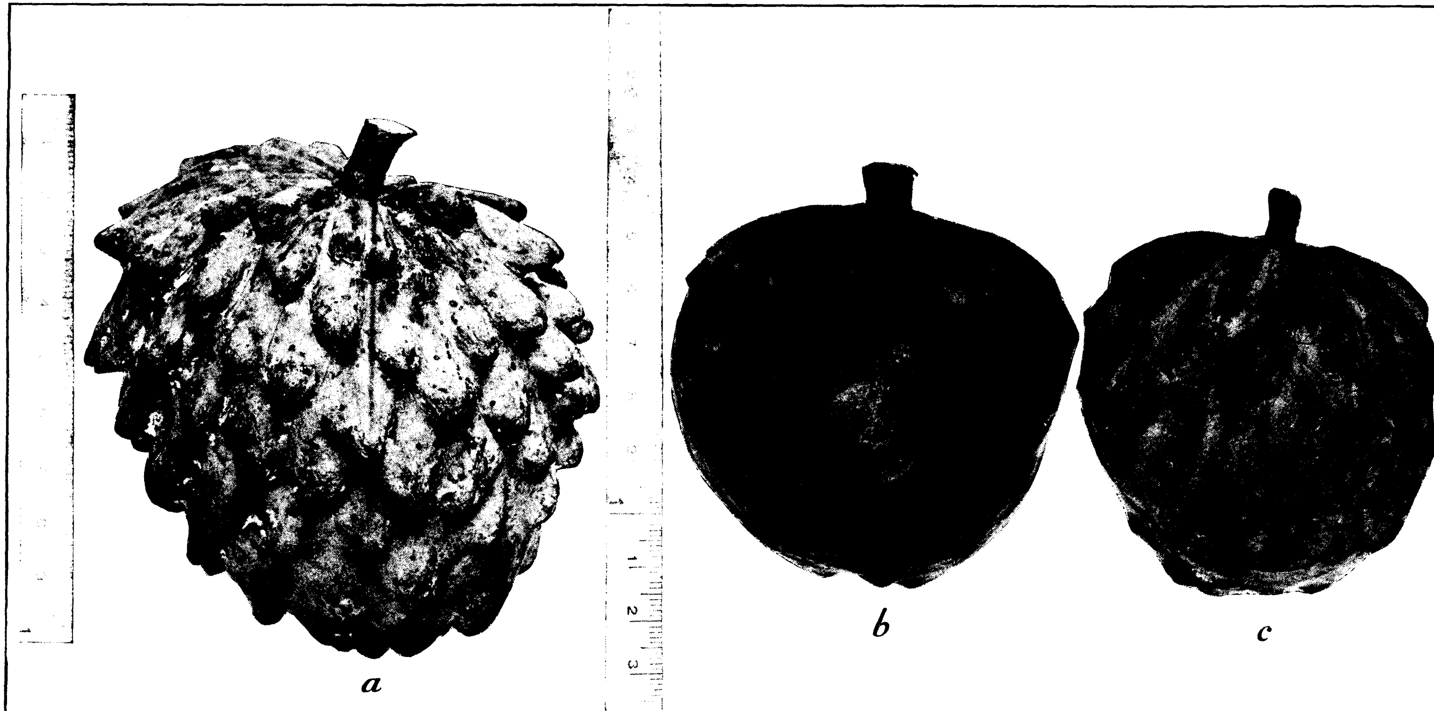


(*a*) Cherimoya, staminate parent. (*b*) Sugarapple, pistillate parent. (*c*) Atemoya, hybrid between sugarapple and cherimoya.



(*a*) Sugarapple. (*b*) (*c*) (*d*) Atemoyas with prominent carpels.



(*a*) Atemoya with prominent carpels. (*b*) and (*c*) Atemoyas with carpels not prominent.

(*a*) Flowering branch of the atemoya (the flowers are identical with those of the cherimoya).

(*b*) Flowering branch of the sugarapple.

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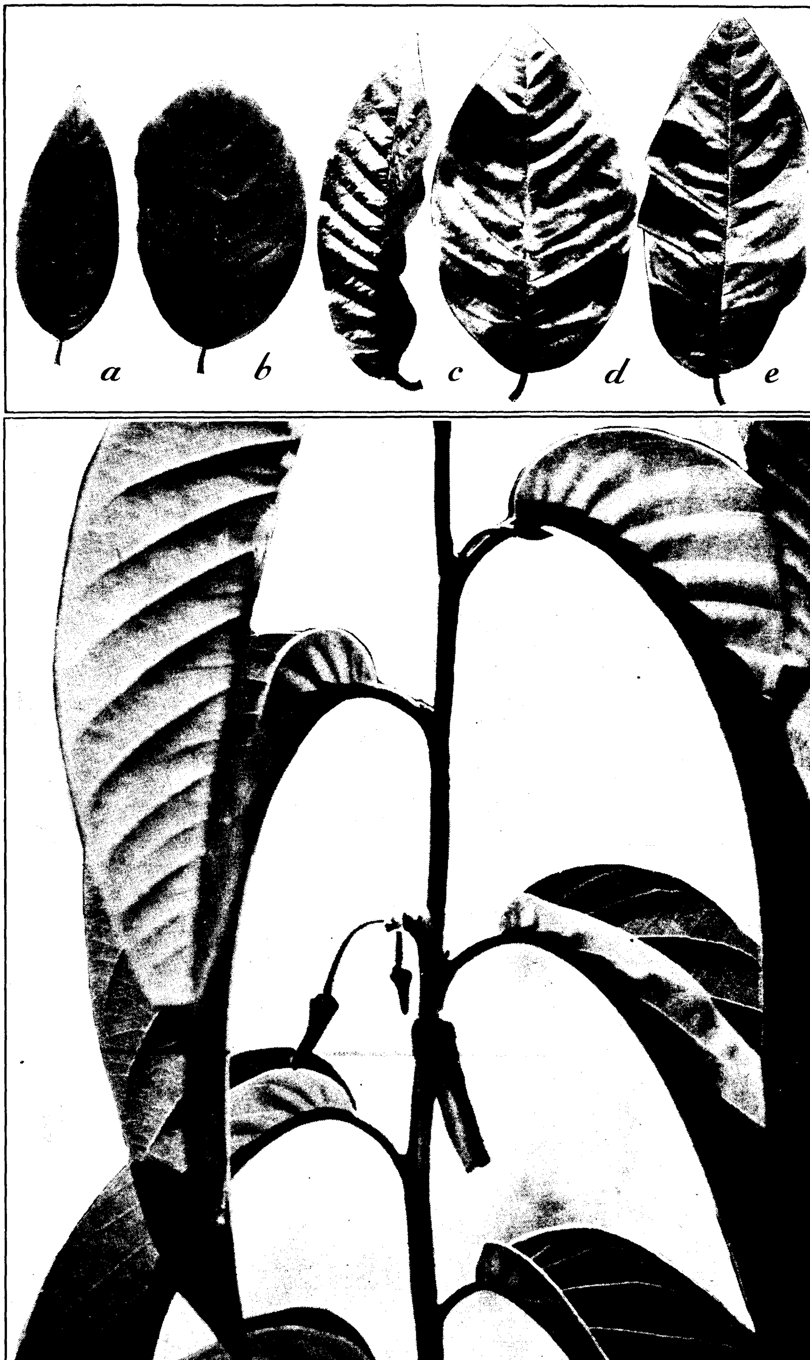

(*a*) Leaf of sugarapple, *Annona squamosa*. (*b*) Leaf of cherimoya, *A. cherimolia*. (*c*) Leaf of custardapple, *A. reticulata*. (*d*) Leaf of atemoya, hybrid between sugarapple and cherimoya. (*e*) Leaf of cuatemoya, hybrid between atemoya and custardapple. (*f*) Flowering branch of the cuatemoya.

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No. 8. Size very small, weight 105 grams; length 56 millimeters; width 50 millimeters; shape irregularly cordiform; carpels prominent, ending in a more or less acute point; areoles distinct; surface pale greenish, mottled with reddish purple dots on sun-exposed side along areolar lines; skin thin to medium thick, brittle; pulp white, very juicy, almost watery, sweet, with a trace of acidity and cherimoya flavor.

Only one of three fruits weighed more than 100 grams. In quality the fruit is a slight improvement on the sugarapple.

No. 9. Size very small, weight 135 grams; length 55 millimeters; transverse diameter 60 millimeters; shape regularly cordiform; carpels equal or a trifle raised; areoles distinct; bloom white; pulp white, juicy, sweet and aromatic, rich, flavor suggestive of cherimoya.

The tree bore one fruit only, quite superior to the sugarapple in quality.

No. 11. (Plates VI, *c*, VII, *d*, VIII, *c*.) Size small to medium; average weight 220 grams; length 74 millimeters; equatorial diameter 62 millimeters; shape cordiform, usually longer than broad, regular; carpels variable, sometimes depressed, usually equal and occasionally quite prominent; areoles distinct; surface greenish with white bloom; skin medium thick of average tenacity; flesh white, juicy, sweet, faintly aromatic, of good flavor, cherimoya flavor absent.

No. 11 bore forty-seven fruits of which twenty-nine weighed over 100 grams with a greater average size than any of the seedlings, one fruit weighing 580 grams. The fruit slightly surpasses the sugarapple in quality.

No. 12. (Plates VII, *c*, VIII, *a*.) Size small; weight from 135 to 255 grams, with an average of 175 grams; length 65 millimeters; transverse diameter 60 millimeters; shape cordiform, regular; carpels ending in a more or less pointed protuberance; areoles distinct; surface green with reddish dots on sun-exposed side; bloom white; skin quite thick and tough; pulp white, juicy, sweet, faintly aromatic, devoid of cherimoya flavor, but of good quality.

Thirteen of the twenty-six fruits of this plant weighed above 100 grams. It is one of the two most attractively colored hybrids. In flavor it slightly excels the sugarapple.

No. 13. One hundred and sixty-five grams in weight; 65 millimeters in diameter; shape cordiform; carpels more or less prominent; areoles distinct; bloom white; skin thin, brittle; pulp white, sweet, juicy, with a trace of cherimoya flavor.

Four fruits were produced on this tree, superior to the sugarapple in quality.

No. 14. Weight 110 to 175 grams; diameter 60 millimeters; shape cordiform, regular; carpels equal or a trifle raised, ending in a protuberance at stigmatic point; areoles large and distinct; surface pale green, granulate; bloom white; skin medium thick, of average tenacity; pulp white, juicy, sweet, with a little or no cherimoya flavor, but of very good quality.

Three of a total of nine fruits reached a development of above 100 grams. The larger areoles and granulate surface in this fruit distinguish it from all the sister hybrids. It is superior to the sugarapple.

No. 15. (Plate VII, *b*.) Weight 100 to 185 grams; length 55 to 63 millimeters; width 53 to 72 millimeters; shape cordiform; carpels very prominent, protuberances dark green and somewhat corrugate, depressed areas yellowish; bloom white; pulp white, juicy, sweet, faintly aromatic, of little or no trace of cherimoya flavor, surpassing somewhat the sugarapple in quality.

This plant bore six fruits of which two weighed 100 or more grams. Remarkable chiefly for its large carpels.

No. 16. One hundred to 155 grams in weight; 53 to 66 millimeters in diameter; shape cordiform, regular; carpels more or less prominent, ending in a pointed, corrugate, dark-green protuberance, sometimes 4 to 5 millimeters long; surface yellowish along areolar lines; bloom white, skin medium thick, quite tough; pulp white, sweet, juicy, faintly aromatic, of good flavor, but devoid of cherimoya flavor.

Of twelve fruits six weighed 100 grams or more. The fruit partakes more of the sugarapple than of the cherimoya in appearance; in quality it excels the sugarapple.

No. 17. Weight 130 grams; diameter 52 millimeters; shape cordiform; carpels prominent, dark-green and corrugate at apex; areoles distinct; bloom white; skin thin and rather brittle; pulp white, juicy, sweet, rich, faintly aromatic, with trace of cherimoya flavor, of good quality.

One only of ten fruits borne by this tree that were tested weighed more than 100 grams. Three attractive fruits of good size dropped from being overripe before they were picked.

No. 22. Weight 115 to 200 grams; length 60 to 63 millimeters; width 59 to 66 millimeters; shape cordiform; carpels equal or slightly raised; areoles distinct; bloom white; skin thin but rather tough; pulp white, a trifle fibrous, juicy, sweet, quite aromatic, well-flavored.

Four of six fruits weighed more than 100 grams. Superior in quality to the sugarapple.

No. 23 bore two undersized prominent-carpelled fruits of good flavor.

The fruits of Nos. 1, 18 and 19 became overripe on the trees and were lost.

It should be remembered that most if not all of the fruits described above were produced by artificial pollination, and since the value of a variety greatly depends upon its productivity, the value of these hybrids to the public is by no means determined, and this cannot be done until after at least three crops of fruits have been recorded.

During 1915 the hybridization work was continued and seventeen successful crosses were made between various atemoya mother plants and the "Giant" cherimoya from Australia, referred to in a previous issue of the Review; twenty crosses were made between the atemoya and the soursop, *A. muricata,* the latter supplying the pollen, four of which resulted in small deformed fruits with few seeds. Eight successful crosses were made between the sugarapple, mother, and the custardapple, *A. reticulata,* which, by the way, was first accomplished in 1908 in Miami, Florida, though the resultant hybrids were lost during the absence of the writer. Ten crosses were made between the sugarapple and the "Giant" cherimoya. Several crosses were also made between the soursop and sugarapple, the soursop and custardapple, the biriba and sugarapple, and the biriba and custardapple, all of which were abortive.

The hybridization was begun April 4 and concluded April 17, and all the fruits on the atemoyas matured before the advent of the rainy period.

The atemoya plants have continued to make excellent growth. They flowered normally in 1915 with abundant blooms. and a fair number of small *Coleoptera* of the family Nitidulidæ being present, a fair crop of fruit was anticipated. It is therefore disappointing to record that very few fruits set where the flowers were not handpollinated. Those that ripened had the distinct flavor and aroma of the cherimoya, and were greatly superior to the fruits from the same trees in 1914, which, it is recalled, matured during the rainy season. It is hoped that as the hybrids grow older they will become more productive.

As will be noted in reading this paper the work has been disappointing so far in several respects and, commercially speaking, no hybrid has yet been produced that is a success. The permanent value of the work lies in the demonstration of the possibility of hybridizing the species under consideration and more particularly in the demonstration of the fact that it is possible to combine in the progeny more or less of the quality of the subtropical cherimoya with adaptability to tropical conditions.

A large number of hybrids from the seeds secured in 1913 and 1914 are now growing and some of the hybrids between atemoya No. 4, and a custardapple, bloomed in 1915 when the plants were about eighteen months old. (Plate X, *e, f.*)

PLANTATION WHITE-SUGAR MANUFACTURE.

By Cleve. W. Hines, M. S., *Station Superintendent.*

The demand for high-grade sugar has become so great that men in every sugar-producing country are seriously considering the advisability of arranging their factories for the production of high-grade sugars directly from the cane juice in one continuous process.

It was the universal custom until quite recently to make a low-grade or crude sugar in the plantation factory and this was afterwards sent to a refinery and converted into a high-grade sugar by the aid of the bone-black or animal-char process. This procedure entailed the expense of transporting the raw sugar to the refinery, costly refining expenses, and again the return transportation on the finished product. In addition to all of these expenses there is a loss of sugar incident to the handling during transportation and refining which would be eliminated were the high-grade sugar made at the plantation factory.

It was formerly believed that the bone-char method was the only one which would produce a first-class sugar but in recent years there have been elaborated numerous systems of clarification and filtration which give a very satisfactory sugar in one continuous process. Sugars are thus produced which have practically as high a purity and as bright a color as those made by the bone-black process.

The sugar manufacturer using cane as his source of sucrose is favored with the advantage that the small amount of impurities which may be left in his product will lend to it a very pleasant flavor. If indeed it were possible to make his sugar perfectly white and have a sharp brilliant crystal, such as is universally demanded by consumers, without removing all of the organic impurities, the sugar would have a distinctive flavor and odor making it far superior to the sugars of a higher purity. It was this quality in the famous Demerara crystals which caused their superiority over other yellow clarified sugars. It should be noted in this connection, however, that only the natural impurities found in mature cane lend these pleasing flavors while those

which are found in deteriorated or damaged cane are of a much lower quality.

When high-grade sugars are made directly from the cane, the expense of manufacture is ordinarily very much lower, since the same skilled workmen as well as the evaporators and other expensive apparatus required for the manufacture of lower-grade sugars will be used. In addition, the bagasse from the cane and occasionally the low-grade discard molasses, two by-products of the plantation factory, will provide the only fuel needed, an otherwise very costly item in the refinery. The first process in the refinery is to melt the crystals, and dilute the solution to a low density, then after the clarification and filtration the sugar is recrystalized. This requires a great deal of extra heat and the attention of specially trained men. The bone-char used in refining is very expensive and while it is customary to use this clarifying and filtering agent over and over again, nevertheless there is a considerable loss during each operation and the cost of reviving or reburning it is quite appreciable.

In some of the Oriental countries, including Java, there has been a demand by the inhabitants, particularly by the Hindus of India, for sugars made without the use of bone-black, since there is a prejudice against the use of any article in the manufacture of which animal substances are used. A search was then made for new methods of clarifying and filtering juices whereby the high-grade sugars could be produced without the use of bone-black.

The beet-sugar manufacturers also conceived the idea of eliminating the refining expenses and elaborated systems of clarification which produced sugars answering quite favorably to the standards of the refinery. This gave rise to the system now used generally throughout the beet-sugar factories which consists of a double carbonation and sulphitation method with careful attention given to filtration. The method as used for beet juices could not very well be employed with cane juices, which contain a high percentage of glucose, since dark products would result from the compound of calcium used in the clarification and glucose and these products are very detrimental to the manufacture of high-grade sugars.

Among the systems enumerated later, there is mentioned one which produces a juice practically as free from glucose as the beet juice. With the glucose eliminated there is no danger of the juice darkening when heated to a high temperature even though it be in an alkaline state. Special treatment and great care, however, are necessary in order to produce such a juice.

The first essential in the manufacture of white sugar directly from the cane juice is to properly strain or filter the juice as it leaves the mills in order to remove as much of the foreign substances as possible and particularly cane fiber. The particles of cane fiber or bagasse thus removed contain coloring substances, which would become quite yellow in an alkaline medium, while the outer tissue contains a great deal of the coloring substance, "anthocyan," which is extremely soluble and is quite noticeable, especially when the darker varieties of cane are used. These are partly soluble in the juice and render the subsequent work more difficult if they are present in large quantities.

The clarification of the juice which is to produce a high-grade sugar should be given the most careful attention. It is essential that the entire process be under the strictest chemical supervision and that only qualified workmen be intrusted with the operations. Errors made at this stage are very difficult or almost impossible to correct later.

Lime is one of the principal agents used in this work. It first neutralizes any acids that may be present, both organic and inorganic. It also acts upon albuminous substances and other organic compounds. These pass to the bottom of the defecators and act to a certain extent as a mechanical precipitant by bringing down other suspended impurities. Only the best quality of burned lime should be used since impurities introduced into the juice with the lime may cause a great deal of future trouble, especially if they consist of such elements as magnesium and potassium which are often present in low-grade lime rock. The lime used for juice clarification results from the burning of lime rock or calcium carbonate. The chemical change which takes place during this process or burning is expressed in the following equation: $CaCO_3$ (calcium carbonate) presence of high temperature $\rightarrow CaO$ (calcium oxide) $+ CO_2$ (carbon dioxide). This calcium oxide is very alkaline and decomposes water during which calcium hydroxide is formed. With this operation, known as slaking of the lime, there is a great deal of heat evolved. On account of this heat and the strong alkalinity produced locally it is usually considered a poor practice to apply lime to cane juices in the oxide or unslaked form. The following equation indicates the reaction which takes place when unslaked lime combines with water: CaO (calcium oxide $+ H_2O$ (water) $\rightarrow Ca(OH)_2$ (calcium hydroxide). Having selected a first-class lime for the clarification work the next question of importance is the proper preparation of it and the addition to the juice of the proper quantity. This will depend upon the particular process employed.

In practically all of the methods now used for making plantation white granulated sugar sulphur dioxide is employed as an acidifying and bleaching agent. This is sometimes applied before the lime so that the acidity of the juice will be increased, thus admiting the use of more lime. In other methods the lime is added first and the sulphur dioxide afterwards. In addition to the above-named action sulphur dioxide serves still other purposes, especially when used in connection with the carbonitation system. There is present in cane juices a certain quantity, though it may be small, of potassium. When this is acted upon by the carbon dioxide, potassium carbonate results. During the boiling of the juice this potassium carbonate is decomposed and the potassium compounds thus liberated have very strong alkaline effects and immediately act upon the glucose present, forming dark-colored products. If the juices are previously subjected to the sulphur treatment, however, this compound would be changed into potassium sulphate which is quite insoluble and the trouble thus eliminated.

Sulphur dioxide gas is usually made in the factory as needed by burning crude sulphur in a properly constructed furnace and conducting the gas through pipes to the juice after it has been thoroughly cooled. The reaction which takes place in the burning of sulphur is as follows: S (sulphur) $+$O (oxygen) presence of high temperature $\rightarrow SO_2$ (sulphur dioxide).

When this gas is absorbed by water in the cold the following formula results: SO_2 (sulphur dioxide) $+H_2O$ (water) $\rightarrow H_2SO_3$ (sulphurous acid). This is a fairly weak acid and is the compound sought for in sugar manufacture. It is formed, however, only when the combination is made at fairly low temperatures while if this should take place with elevated temperatures, the following formula would result: SO_2 (sulphur dioxide) $+H_2O$ (water) $+$O (oxygen) presence of high temperature $\rightarrow H_2O_4$ (sulphuric acid). This acid is extremely powerful and will not only destroy sucrose, but will corrode the iron containers of the juice as well. For this reason care should be exercised that the gasses are properly cooled before coming into contact with moisture.

It is very important that the sulphur be properly burned so that a gas with as high a percentage of the sulphur dioxide as possible be attained. The theoretical amount attainable is about 21 per cent. Usually, however, a gas with not more than 17 to 18 per cent is received in practice.

Carbon dioxide gas is also extensively used with many of the processes. This gas is recovered as a by-product from the burning of limestone and is used for the precipitation of the

calcium and impurities in juice clarification. The following formula expresses the reaction which takes place when the gas combines with calcium hydroxide: $Ca(OH)_2$(calcium hydroxide)$+CO_2$(carbon dioxide)$\rightarrow CaCO_3$(calcium carbonate$+H_2O$-(water). This calcium carbonate is quite insoluble and acts as a mechanical precipitant in addition to the chemical effect of the two components.

Proper temperature regulations during clarification form a very important factor, which must not be neglected, and it is only with close attention to such details that good results may be attained.

The next operation is the proper subsidation of the juice whereby the heavy impurities will settle to the bottom while the clear juice remains at the top and is decanted or drawn off. This procedure eliminates the filtering of the entire quantity of the juice which contains so many impurities that it would be a very difficult task since the impurities form a gelatinous coating over the cloths of the filter presses thus preventing the penetration of the juice. Since the impurities settle out of the clarified juice very completely, if the work has been properly done, there is usually little to be gained by filtering the clear supernatant liquor.

The handling of the juice after this stage will be determined by the particular process employed, the condition of the original juice and the grade of the finished product required. When it is desired to make the highest grade of refined sugar special attention must be given to proper juice clarification and subsidation. In some cases a second application of the above reagents may be necessary while in others such additional reagents as "blankit" or sodium hydrosulphite. Phosphoric acid, sodium or calcium phosphate, etc., may be employed to advantage after the first concentration or syrup stage is reached. It is sometimes desirable to treat the concentrated product and thus remove still more impurities, but this is not ordinarily necessary when the work has been properly done in the previous operations. The following brief description of various processes will serve to indicate the general principles involved in each.

Harloff's acid thin-juice process.—This is a carbonitation-sulphitation process, the main features of which are based on the principle that there is present in all carbonated juices calcium carbonate and bicarbonate, calcium sulphate and some potassium in the form of a carbonate. Upon decomposition of the latter during the concentration of the juice a dark color will be taken on by the thick liquor unless its chemical composition is previously changed. Calcium sulphate being more

stable will not be so susceptible to this change and consequently the thin juice is made distinctly acid with sulphur dioxide before concentration is begun, which has the additional effect of clarifying and bleaching the juice.

Battelle process.—This method was patented by Mr. E. E. Battelle of Hawaii and aims at producing a juice for concentration which is very similar to clarified beet juice. His first step is to remove the glucose content of the juice which is accomplished by heavily liming and heating the juice to a high temperature. The juice is then treated with carbon dioxide, filtered, retreated with lime and carbon dioxide, and, if found necessary, again filtered, bleached with sulphur dioxide or treated with phosphoric acid and concentrated. The molasses is passed through a cold saccharate process somewhat similar to the Steffens process whereby the greater percentage of the sucrose is removed.

The Reserve or Sandmann system.—This system was elaborated by Mr. B. Sandmann after many years of application to the subject of plantation white-sugar manufacture at the Reserve sugar factory of Louisiana.

Briefly stated, the system consists of heavily sulphuring the raw juice and liming it down to an acidity of about 1.2 cubic centimeters against 1/10 sodium hydroxide, using Phenolphthalein as an indicator. The juice is then heated to the desired temperature and placed in subsiders for a time after which the clear juice is drawn off. The portion of the juice containing the sediment is then filtered through presses. Before boiling the clarified juice is treated with a special sodium-phosphate paste which has an acidity practically equal to that of the clarified juice. This has the effect of decreasing the amount of calcium remaining in the juice, thus giving a solution which will be more easily boiled and will work better in the machines. By this treatment there is more of the sulphite removed, a part of which would otherwise be admitted into the sugar together with a trace of glucose and other reducing compounds which would later transfer it into sulphide and thus cause the sugar to darken.

Java process.—This method varies somewhat with the different factories but consists in general of single or double carbonitation, subsidation, filtration and bleaching with sulphur dioxide, particular attention being given to the control of temperatures, alkalinities or acidities of juices and sirups.

Adeline or Oxnard process.—The essential features of this process consist of heavily sulphuring the juice to admit of more lime being used, and reducing the acidity to about one cubic

centimeters against N/10 sodium hydroxide, using phenolphthalein as an indicator. The juice is then subsided, treated with phosphoric acid, and again limed if necessary. It is then filtered and concentrated.

The thick juice is still further treated with phosphoric acid or sulphur dioxide if necessary.

Dehann process.—This is a carbonation system designed to minimize the amount of lime used for the clarification of the juice by causing the calcium carbonate to be crystallized in a firmer and more granular form which is more readily removed by subsidation and filtration.

Bach process.—It is observed that corrosion of the evaporators and loss of sucrose through inversion result when the juices are carried in an acid condition during concentration. For this reason the Bach system was devised by which the sulphur dioxide treatment of acidifying the juice is given after the syrup stage is formed; until this time the juice is kept neutral.

Weinrich process.—The one unique feature of this process consists in the application of dry lime to the raw juice instead of the slaked or hydrated form as is universally employed. It is interesting to note in this connection that sugar manufacturers have always been very much averse to the application of lime to cane juice except in the hydrated form, assuming that such treatment would be extremely dangerous to the color of the juice because of the reducing sugars present, since there would be local heating of the juice from the heat evolved by the chemical action during the slaking of the lime. There is also likely to be a high alkalinity thus formed in the portions of juice which come into direct contact with the calcium oxide.

Roselle process.—This system consists of first thoroughly removing the "bagasillia" from the juice, sulphuring heavily, liming and subsiding. Phosphoric acid is then applied, when required, and the resultant precipitate carefully filtrated.

Wijnberg and Spaner process.—This is a patented system consisting of the application of decolorizing carbons to the limed and sulphured juice, and the application of a limited quantity of "Kieselgvhr," after which the juice is filtered. The decolorizing carbons are removed with the filtrate and revivified by treatments with caustic alkali and washing.

Weise process.—This is a carbonitation process in which two or three per cent of lime is added to the raw juice before the gas is applied. Subsequent work consists of subsidation, filtration and bleaching.

Steffens process.—This process was the result of a great deal of experimenting and was improved step by step starting with what was known as the "elution process."

It deals with the principle that calcium combines with sucrose to form monocalcium, dicalcium and tricalcium saccharate, depending upon the working conditions.

The saccharate mainly formed in the cold is the monocalcium and this is soluble only with difficulty in 200 parts of water and almost insoluble in a solution of calcium hydroxide. It is therefore possible to filter off this compound after which the sugar may be freed by the simple application of carbonitation.

This method is used extensively in the beet-sugar industry and a modification of it is now coming into use in one of the newer processes of the cane-sugar industry.

Other processes.—Among the long list of other methods recommended for the extraction of sugars may be mentioned the "Norit," "Clarite," "Soxhlet," "Ranson," "Manoury," "Kopke," "Garthley," "Gordon," Electrolytical, Barium, Strontium, Hydrogen-peroxide and Phosphoric Acid.

Principles of manipulation and reagents.—It will be observed that the methods available to the manufacturer for the making of high-grade sugar directly from the raw material are numerous and that the general principles involved are identical in many of them, but specific attention is given to temperatures, acidities, alkalinities, clarifying reagents and time of their application, as well as a careful chemical control of each part of the work. One who thinks of building a plant for the manufacture of white sugar or changing his present plant to one of that kind should carefully consider the class of raw material he will use and his working conditions, before deciding upon any particular method.

METHODS USED TO IMPROVE RICE CULTURE IN THE PHILIPPINES.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

From 1894 to 1896, while the "Boletin Oficial Agricola de Filipinas" was being published monthly by the Spanish Government, many interesting and valuable reports were made of public record. Very little, however, is to be found in the three volumes on the subject of rice culture. There are accounts of fertilizer experiments and cultural tests, and 151 varieties are named. (See this REVIEW, Vol. I, 1908, No. 8, p. 307.)

Following the harvest of the rice crop of 1908, three Filipino agricultural scientific assistants who had been educated in the United States were detailed on the work of collecting data relating to rice culture as practiced in these Islands, and securing samples of seed of varieties.

In the thirty provinces visited, 828 samples of seed were secured and 2,430 variety names listed.

From the samples then on hand 200 so-called varieties of lowland rice and 56 of upland rice were selected for comparative tests. The seed-beds of the lowland varieties were sown in June, 1909, at the Alabang stock farm, and the upland varieties were planted immediately thereafter.

This was the beginning of systematic rice work and was directed by the then Acting Director of Agriculture, Prof. Charles M. Conner.

A big problem was the devising of means for identifying varieties so that all duplicates could be eliminated early, and for providing a general scheme for classification. First of all, the varieties were divided into two large classes according to adaptability, upland (or highland) and lowland.

Each of these was subdivided into two classes according to presence or absence of awn. These in turn were further divided according to composition of kernel as glutinous or non-glutinous, and the resulting classes into others according to the color of cuticle.

The classification fell into sixteen groups, as a hypothesis, as indicated below.

- RICE
  - Lowland
    - Non-bearded
      - Non-glutinous: White. Colored.
      - Glutinous: White. Colored.
    - Bearded
      - Non-glutinous: White. Colored.
      - Glutinous: White. Colored.
  - Upland
    - Non-bearded
      - Non-glutinous: White. Colored.
      - Glutinous: White. Colored.
    - Bearded
      - Non-glutinous: White. Colored.
      - Glutinous: White. Colored.

As a matter of fact it was found that for practical purposes a much lesser number of classes was necessary, as will be shown later. On the other hand the classification could have been extended *ad infinitum* without adding to the value of the scheme. A very comprehensive classification scheme was devised later by S. Kikkawa, of the Tokyo College of Agriculture. (Vide Vol. III, No. 2, Journal of the College of Agriculture, Imperial University of Tokyo, Sept., 1912.)

There are on record 1,011 varieties which have been tested out and identified. Of these, 158 have been found to be duplicates.

The remainder is found in thirteen classes as follows:

Lowland:

118—Bearded, non-glutinous—white.
162—Non-bearded, non-glutinous—white.
19—Bearded, glutinous—white.
3—Bearded, glutinous—colored.
8—Bearded, non-glutinous—colored.
2—Non-bearded, non-glutinous—colored.

Upland:

307—Non-bearded, non-glutinous—white.
45—Non-bearded, glutinous—white.
1—Bearded, glutinous—white.
6—Bearded, non-glutinous—white.
46—Non-bearded, non-glutinous—colored.
35—Non-bearded, glutinous—colored.
1—Bearded, non-glutinous—colored.

For convenience, of the varieties with kernels having colored cuticle, sub-divisions were made, one of red and the other black. Thirty-three varieties were found in which the color of the cuticle was so deep that it could not be called red, and for practical purposes it did not matter if the deeper colored ones were merely a deep-dull purple or some other color closely resembling black, hence the term applied was deemed sufficiently accurate. The varieties were classified as follows:

Lowland:
- 2—Non-bearded, non-glutinous—black.
- 4—Bearded, non-glutinous—black.
- 1—Bearded, glutinous—black.

Upland:
- 8—Non-bearded, non-glutinous—black.
- 17—Non-bearded, glutinous—black.
- 1—Bearded, non-glutinous—black.

It will be noted that neither a non-bearded, glutinous white, nor a non-bearded, glutinous colored variety was found among the lowland rices, while 45 of the non-bearded glutinous white, and 35 of the non-bearded glutinous colored, were found among the upland rices, but no example of bearded glutinous colored, of which there were three among the lowland rices.

It should be understood that classification of rice into two big classes of lowland and upland may be a somewhat arbitrary matter. We have found that there is much confusion among farmers and others as to what is the proper classification for a given variety.

According to our definition an upland variety is one which is either sown broadcast, or planted in hills or drills, on soil which is prepared in a dry state. The preparation of the soil and the planting are done as would be the case if oats, wheat or barley were to be grown. Irrigation may or may not be practiced. Here we do not irrigate such rice. Varieties suitable for culture under these conditions are characterized by much larger, and somewhat broader leaves. Compared with strictly lowland varieties the leaves of upland varieties are 41 per cent longer and 20 per cent wider. (See this REVIEW, Vol. VI, 1913, No. 2, page 91) The surface of the leaves of upland varieties are usually smooth to the touch while those of lowland varieties are catchy. Upland varieties may be regarded as being less sensitive to drought than lowland varieties.

Lowland varieties are such as are planted in soil which is puddled in preparation. The seed may be sown broadcast on the field or the seedlings transplanted thereto. Many people

are confused when they find lowland rice grown at altitudes approaching a mile and upland rice grown only a few feet above sea-level.

We have found varieties which may be grown successfully under strictly upland culture and as well when transplanted in puddled soil, and they may also be grown fairly well when sown broadcast on such soil. One of the best varieties of rice yet found appears to be perfectly suited to lowland conditions, yet in many districts it is grown and known only as an upland variety. Many upland varieties do not thrive in puddled soil and literally "drown" when planted in paddies.

There is a great difference in the behaviour of lowland varieties when sown broadcast in puddled soil, some seeming to be much better suited for such treatment than others.

For culture under the "dapog method" as described in this REVIEW, Vol. VIII (1915), No. 2, a very high mortality of seedlings is experienced with some varieties when transplanted at the early age required by this method.

At the beginning, it appeared that nothing was more important than to learn the relative values of varieties with special reference to yield and quality of grain. As a consequence plot testing of varieties was carried out on a quite comprehensive scale. The lowland varieties were grown in three provinces on different types of soil and under different climatic conditions, yet the relative positions of varieties did not differ much when the reports of the respective stations were compared. With varieties being grown in duplicate plots in three differing districts the results obtained were deemed to be reasonably dependable. This would hardly be the case with upland varieties, with which the water supply was not under control.

The plot-testing work is briefly outlined below:

Year.	Number of varieties.	
	Lowland.	Upland.
1909	200	56
1910	381	365
1911	400	474
1912	128	247
1913	130	247
1914	47	44
1915	61	53

When the 1913 and 1914 crops had been harvested, there were data on record showing the performance of many varieties over a period of five years. Naturally, a large mass of data

[Face.]

ORYZA SATIVA — **VAR. NAME:** ______ **WHERE FOUND:** ______

ADAPTABILITY: Highland / Lowland — **GRAIN:** Awned / Awnless — **HULL:** Solid color / Non-solid color — **KERNEL:** Glutinous / Non-glutinous — **CUTICLE:** White / Colored — **AGE:** Heading days. / Maturity days.

TESTED AT ______ **DATE** ______ **GROWER** ______

CULTURE: Highland—broadcast, drill, hill (caiñgin) / Lowland—broadcast, transplanted (age of seedling days) — **CONDITIONS:** Soil — **Fertilizer**

Moisture: Irrigation / Rainfall in inches—1st mo. , 2d mo. , 3d mo. , 4th mo. , 5th mo. , 6th mo. , 7th mo. — **Temperature:** max. °C. / min. °C.

PLANT—

YOUNG PLANT: (28 da. old) Number of leaves / Height to tip of leaves cm. — **COLOR:** of trunk / of blades — of base of blade / of edges of blade — of ligule / of auricle

AT HEADING: UNIFORMITY: not uniform, fairly uniform, medium, very uniform — **COLOR:** of anthers / of stigma — of empty glume / of awn

of grain / of tip of grain — of culm / of node — of sheath: int. sf. , ext. sf. / of blade: up. sf. , low. sf.

of base of blade / of edges of blade — of ligule / of auricle — **HEIGHT:** cm. — **GROWTH:** erect, medium, open, very open.

FOLIAGE: Nature: stiff, heavy, medium, weak. / Abundance: scanty, medium, abundant. — **BLADE:** Upper surface: scabrous, catchy, smooth. / Lower surface: scabrous, catchy, smooth. — Midrib: scabrous, catchy, smooth. / Edges: scabrous, catchy, smooth. — Length cm. / Width cm.

AT MATURITY: RIPENING not uniform, fairly uniform, medium, very uniform. — **STOOLING:** Number of culms / % of bearing culms — **CULM:** Length cm. / Diameter — **Color** int. surf. / ext. surf.

Wall of Culm thin, rather thin, medium, rather thick, thick. — **Node** Average number per culm / Color — **FOLIAGE: Color of Sheath** int. sf. / ext. sf.

of blade: up. sf. , low. sf. / of base of blade — of ligule / of auricle — **RACEME:** Length cm.; close, rather close, medium, rather open, very open. — No. spikelets on base

Ave. no. of spikelets per raceme / Ave. no. of grains per raceme — **GRAIN:** single or bunching 2, 3, 4, 5, 6. — **Shape** Outline: orbicular, oval, elliptical, oblong, lanceolate, oblanceolate, ovate, obovate. / Thickness: granular, cylindrical, thin, medium, plump.

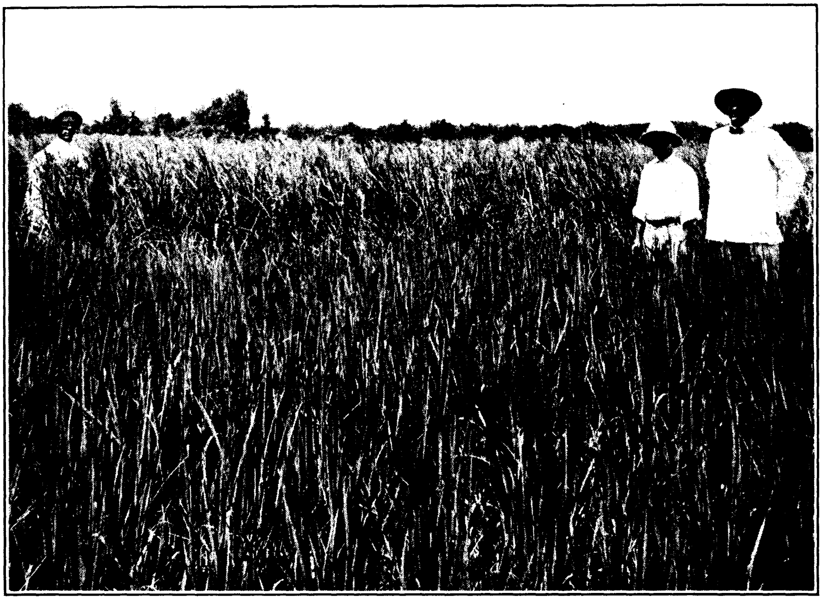
Length cm. / Width cm. — Color of body / Color of tip — **HULL:** thin, medium, thick; glabrous, scabrous, somewhat hispid, hispid, very hispid. — **EMPTY GLUME:** Length (relative to grain) / Color

AWN: Length: v. short, short, medium, long, v. long. / Color — **KERNEL:** Length cm. / Width cm. — **Color** cuticle: / endosperm: v. white, white, dirty white, blackish, reddish, amber.

Density of Endosperm: partly vitreous, greatly vitreous, vitreous, greatly white or chalky — Aroma and Flavor; non-aromatic, aromatic, very aromatic — % of hull to grain by weight — **SPECIFIC GRAVITY:** Paddy / Clean rice

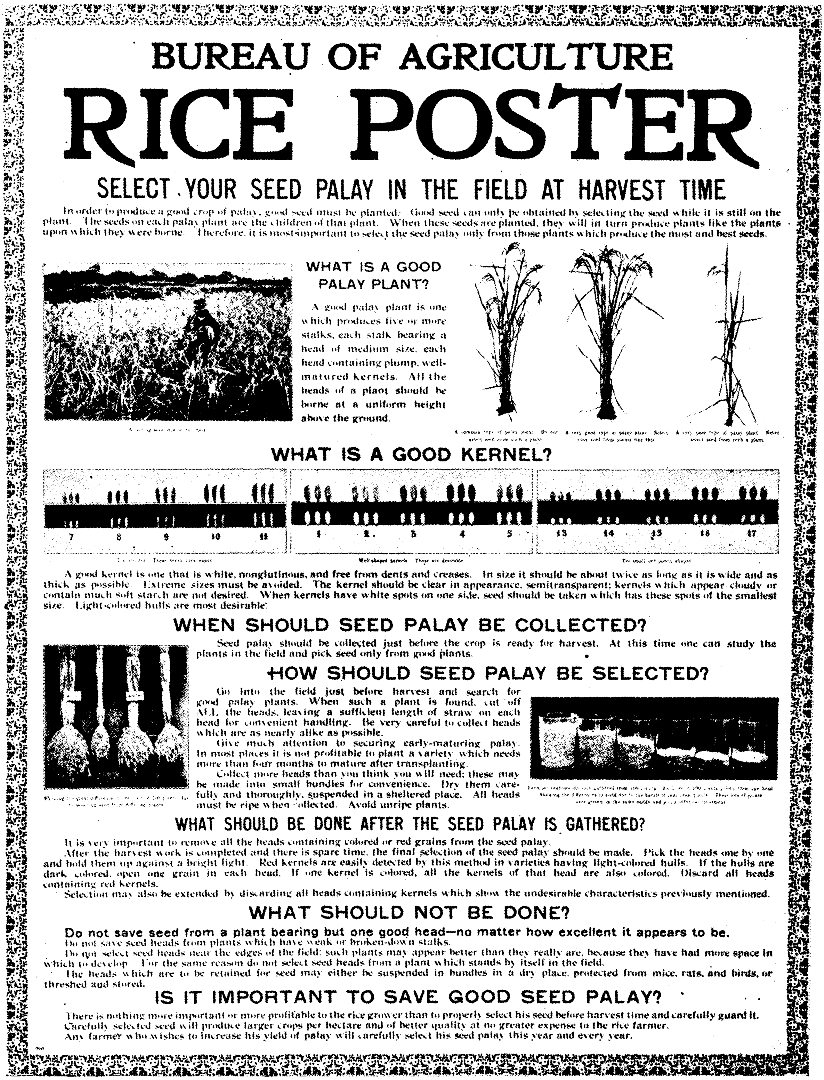
YIELD PER HECTARE: Liters . / Kilos . — Wt. of 75 liters paddy K. / Wt. of 75 liters cl. rice K. — **SHATTERING QUAL:** very easy, easy, medium, tight, very tight. — **MILLING QUAL:** poor, fair, medium, good, very good.

REMARKS:



(*a*) In the background, a selected variety of rice in bloom; in the foreground, an ordinary variety due to bloom in two months, provided the rainfall is sufficient.

(*b*) A cooperator and his rice plot.



BUREAU OF AGRICULTURE

RICE POSTER

SELECT YOUR SEED PALAY IN THE FIELD AT HARVEST TIME

In order to produce a good crop of palay, good seed must be planted. Good seed can only be obtained by selecting the seed while it is still on the plant. The seeds on each palay plant are the children of that plant. When these seeds are planted, they will in turn produce plants like the plants upon which they were borne. Therefore, it is most important to select the seed palay only from those plants which produce the most and best seeds.

WHAT IS A GOOD PALAY PLANT?

A good palay plant is one which produces five or more stalks, each stalk bearing a head of medium size, each head containing plump, well-matured kernels. All the heads of a plant should be borne at a uniform height above the ground.

WHAT IS A GOOD KERNEL?

7 8 9 10 11 1 2 3 4 5 13 14 15 16 17

A good kernel is one that is white, nonglutinous, and free from dents and creases. In size it should be about twice as long as it is wide and as thick as possible. Extreme sizes must be avoided. The kernel should be clear in appearance, semitransparent; kernels which appear cloudy or contain much soft starch are not desired. When kernels have white spots on one side, seed should be taken which has these spots of the smallest size. Light-colored hulls are most desirable.

WHEN SHOULD SEED PALAY BE COLLECTED?

Seed palay should be collected just before the crop is ready for harvest. At this time one can study the plants in the field and pick seed only from good plants.

HOW SHOULD SEED PALAY BE SELECTED?

Go into the field just before harvest and search for good palay plants. When such a plant is found, cut off ALL the heads, leaving a sufficient length of straw on each head for convenient handling. Be very careful to collect heads which are as nearly alike as possible.

Give much attention to securing early-maturing palay. In most places it is not profitable to plant a variety which needs more than four months to mature after transplanting.

Collect more heads than you think you will need; these may be made into small bundles for convenience. Dry them carefully and thoroughly, suspended in a sheltered place. All heads must be ripe when collected. Avoid unripe plants.

WHAT SHOULD BE DONE AFTER THE SEED PALAY IS GATHERED?

It is very important to remove all the heads containing colored or red grains from the seed palay.

After the harvest work is completed and there is spare time, the final selection of the seed palay should be made. Pick the heads one by one and hold them up against a bright light. Red kernels are easily detected by this method in varieties having light-colored hulls. If the hulls are dark colored, open one grain in each head. If one kernel is colored, all the kernels of that head are also colored. Discard all heads containing red kernels.

Selection may also be extended by discarding all heads containing kernels which show the undesirable characteristics previously mentioned.

WHAT SHOULD NOT BE DONE?

Do not save seed from a plant bearing but one good head—no matter how excellent it appears to be.

Do not save seed heads from plants which have weak or broken-down stalks.

Do not select seed heads near the edges of the field; such plants may appear better than they really are, because they have had more space in which to develop. For the same reason do not select seed heads from a plant which stands by itself in the field.

The heads which are to be retained for seed may either be suspended in bundles in a dry place, protected from mice, rats, and birds, or threshed and stored.

IS IT IMPORTANT TO SAVE GOOD SEED PALAY?

There is nothing more important or more profitable to the rice grower than to properly select his seed before harvest time and carefully guard it.

Carefully selected seed will produce larger crops per hectare and of better quality at no greater expense to the rice farmer.

Any farmer who wishes to increase his yield of palay will carefully select his seed palay this year and every year.

Poster distributed throughout rice-growing sections. This poster was also printed in Spanish and the five principal native dialects.

UNIV. OF MICH.

(*a*) Farmers visiting the "Rice Special." During its trip through the provinces more than 30,000 visitors were received by the men in charge.

(*b*) Modern agricultural implements carried by the "Rizal Special;" these received considerable attention.

(*c*) Visiting farmers testing the implements exhibited on the "Rice Special."

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[Back.]

NOTE.

For the purpose of securing uniformity of results, the following notations should be observed:

GENERAL.

1. Much of the accuracy of this work depends on the amount of good judgment exercised in making the field observations and in gathering the samples for the laboratory:
   (*a*) Work on the average; but
   (*b*) If there is a very wide variation, note also the limits—i. e., the maximum and the minimum, viz: 0 to 3, 2 to 5, $\frac{1}{6}$ to $\frac{2}{3}$, medium to long (or very long), etc.

FIELD.

1. Height of young plant—measured from the ground to the common ending of most blades.
2. Length of culm (should not be taken before the plant has fully headed out)—measured from the ground to the base of the raceme, which may or may not have spikelets.
3. Diameter and thickness of culm—to be observed during ripening or at maturity at a point about 3 or 4 cm. below the uppermost sheath-node. Average of 10 culms.
4. Dimensions of leaves—to be taken from the *second* blade from the top. Average of 10 leaves.
5. Stooling—By this is meant the average number of culms developed from each original grain or seedling, and is to be expressed in figures, as 2, 5, 7, 8, 10, 16, or whatever the number may be. This observation should be taken at or after the heading period.

LABORATORY.

1. Length of raceme—measured from its base (which may or may not have spikelets) to the tip of the uppermost flowering glume. Average of at least 5 heads.
2. Length of awn—under 2 cm., very short; 2 to 4 cm., short; 4 to 6 cm., medium; 6 to 8 cm., long; and 8 cm. or longer, very long. (Sometimes it is necessary to express the length thus: very short to short, medium to long, or other combinations.)
3. Length of empty glume—This is expressed in fractional numbers with relation to the grain to which it is attached, viz: $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, 1, $\frac{6}{5}$, etc.
4. Length and width of the grain or kernel—The average of 10 grains or kernels.
5. Color of cuticle—The most common colors are: White, creamy white, red, light red, salmon, light brownish-red, light reddish-brown, black, purplish-black, *partly* black (or purplish-black) and red (or light red, brownish-red, reddish-brown, etc.).

were on file from which valuable information could be deduced. Unfortunately, there has been no opportunity as yet to put this material into shape for publication.

The very important matter which received early attention was to provide a scheme for the positive identification of each variety.

An identification card (pp. 194, 195) was accordingly devised by Silverio Apostol, agricultural inspector, which served very well for the purpose. With use, the card has become modified somewhat, but in the main it has been sufficiently elaborate to cover all points for observation, deemed essential.

Due to the elimination of duplicates, 165 lowland varieties were planted at the Alabang stock farm in June, 1910, which had been grown there during the preceding season and 216 varieties which had been secured from various sources during the year.

Of upland rice, 365 varieties were planted at the Lamao experiment station, as it was believed that the conditions there were more suitable for upland rice. At each of the stations the observations were made and recorded by a man trained in such work.

In 1911, 400 varieties of lowland rice were continued in plot tests at the Alabang stock farm, and at another station established on the Luisita Estate, San Miguel, Tarlac, Tarlac, where the tests were duplicated. At the Lamao experiment station, 474 varieties of upland rice were handled in plot tests.

In the treatment of lowland varieties the following rules were observed. The seed was sown in nursery beds one square meter in area. At transplanting time the seedlings were taken only from the center of the nursery bed. The duplicate plots were 1.5 by 10 meters in dimension and on these plots the seedlings were set out, singly, spaced 25 centimeters apart in the rows, the rows also 25 centimeters apart.

Every precaution was made to provide identical conditions for all the varieties being tested.

With the accumulated data on hand covering three years of work with rice, Prof. Conner wrote Bullettin No. 22, entitled "Rice Culture in the Philippines." This bulletin contains a brief sketch of the work which had been done, and lists 25 of the highest-yielding white non-bearded non-glutinous, and 12 white bearded non-glutinous lowland varieties, also 25 upland white non-glutinous non-bearded varieties, and general instructions on rice culture.

Altogether, 910 varieties had been collected, 452 lowland and 458 upland. Of these, 134 lowland varieties and 6 upland were bearded.

From page 32 of Bulletin No. 22, the following extracts are taken:

> There seems to be very little difference in the average yield of those (varieties) maturing in 140 days as compared with those maturing in 186 days. * * *
>
> Of the total number of white, non-glutinous, non-bearded lowland varieties tested, 33, or 20.6 per cent, gave an average yield of less than 1,000 kilos of palay per hectare; 58, or 36.2 per cent, ranged between 1,000 and less than 2,000 kilos; 69, or 43.1 per cent, ranged between 2,000 and 3,400 kilos.
>
> Of the bearded varieties of this same class, 5, or 4 per cent, gave an average yield of less than 1,000 kilos per hectare; 66, or 53.6 per cent, ranged between 1,000 and less than 2,000 kilos; 52, or 42.3 per cent, ranged between 2,000 and 2,800 kilos.
>
> Of the red, non-glutinous, non-bearded lowland varieties, 6, or 12.7 per cent, gave an average yield of less than 1,000 kilos per hectare; 19, or 40.4 per cent, ranged between 1,000 and less than 2,000 kilos; 22, or 46.8 per cent, ranged between 2,000 and less than 3,000 kilos.

Generally speaking, a variety which averages less than 2,000 kilos rough rice per hectare in yield is unprofitable, hence, according to the above statement more than one-half of the lowland varieties were unprofitable.

A puzzling feature of the work constantly encountered was the appearance in many cultures of rice with colored cuticle, in spite of all efforts made to exclude them. Another point was the relatively low yields obtained when compared with possible yields. It should be stated, however, that low yields were in part attributable to the quality of the soil at the Alabang stock farm, which is very deficient in organic matter and somewhat lacking in several mineral elements. If rice lands were classified into three grades it would fall within the limits of the middle grade.

In order to conclusively eliminate all red rice from the seed to be used in the 1912 plot tests, the transparency test, as used in Indo-China, was applied to all the seed, and all kernels having red or reddish cuticle were removed.

During the year, a test to determine the most suitable spacing of hills in the paddy was made; also a test with lowland varieties of varying requirements as to time to mature, planted in January so as to mature during the hot season, from which conclusions were drawn that no variety requiring more than 150 days to mature was suitable for this purpose; and two comprehensive fertilizer tests which were inconclusive. A limited number of farmers were also induced to plant small amounts of seed of the varieties known to be most productive.

A large number of varieties were eliminated from the plot tests

in 1912. Only 128 varieties of lowland were planted at the Alabang stock farm, and the upland rice work was transferred from the Lamao experiment station to the La Carlota experiment station where 247 varieties were planted in the plot test. A substation for testing lowland varieties was located on the Roxas Estate in Laguna Province.

Of the lowland varieties included in this season's operations, 90 had given an average yield for two years or more exceeding 2,000 kilos per hectare of rough rice.

Other tests conducted were as follows: a test to determine the effect of the age of seedlings at transplanting time upon yield; a test to determine proper distances at which to space hills of transplanted rice and the proper number of seedlings per hill; and, a test to determine the proper quantity of seed to use on a given area of nursery seed bed to insure maximum vitality of seedlings.

The writer, formerly detailed on investigations concerning corn, took up the matter of selection work with rice and when the 1912 crop was being harvested, made selections for planting the succeeding season. This work has been briefly alluded to in an article published in the Philippine Agricultural Review, Vol. VII (1914), No. 9, page 346.

It was realized that the method of beginning with a single grain might prevent handling somewhat larger amounts of material, but the possibility of more rapid progress in using the entire heads is of such value that the head-to-the-row method was adhered to.

Considerable study was made of the probable effects of water temperatures on rice-plant growth, and as an outcome of this work further studies were made on the effects of water-supply on growth.

In 1913, 130 varieties of lowland varieties were carried in plot tests at the Alabang stock farm and on the Roxas Estate, Calauan, Laguna, and 247 varieties of upland rice at the La Carlota experiment station.

The other lines of investigation pursued during the preceding year were continued.

During 1914 the number of varieties continued in plot tests was considerably reduced. Only 47 varieties of lowland varieties were continued in culture at the Alabang stock farm and on the Roxas Estate and 44 varieties of upland rice at the La Carlota experiment station.

Several hectares were devoted to seed propagation of varieties which had been subjected to careful "mass selection" for years.

The extension of pedigree work required considerable area. The investigations with regard to the features of rice culture, as outlined for 1912, were continued.

Two special features of the work with rice were developed during the year.

The field agents operating in various rice-producing provinces were supplied with the best seed, which had so far been produced by the plant-industry division. This seed was put up in small canvas sacks holding three liters, and specific planting intructions were supplied on a printed slip of paper which was placed in each parcel.

The field agents secured farmer coöperators to cultivate these varieties of rice on small plots located in the fields which they were planting with the usual varieties. (Plate XI, *a*, *b*).

In round numbers, 1,200 farmers took hold of this proposition, and did the work under the field agents' supervision. Last season was a trying one for most rice varieties, especially the more prevalent sorts which require 180 days to mature. Practically no rain fell after October first and large areas dried up and were not harvested.

The abundant yield of the small plots planted with selected seeds was, in many cases, far beyond the most sanguine expectations. Again and again reports were submitted, showing that in fields shriveling on account of the drought the small demonstration plots were yielding, in farmers' parlance, at the rate of from 60 to 100 fold.

When it is borne in mind that the average yield for these Islands was but 18.26 cavanes to the hectare for 1914, a yield of from 60 to 100 cavanes was really notable. In most cases no further demonstration was necessary to convince the farmers of the value of better seed. The disposition of surplus seed of these varieties was a somewhat difficult matter. Many farmers had more seed than they needed for the ensuing season's planting and the local rice millers offered a premium over market prices for this surplus, consequently much valuable material which should have been carefully saved for seed was disposed of otherwise.

The drought tended to center public attention on the question of the selection of more suitable and more productive varieties for general planting, and this office initiated an educational campaign on the subject of the importance of seed selection and methods to be employed.

The slogan was "Select your seed (palay) in the field at harvest time."

There are many instances on record of corn-growing com-

munities conducting campaigns, directed along lines to promote the proper selection of seed corn. We have heard of "Seed-corn days" and "Seed-corn weeks," but we believe this is the first instance of a campaign to induce the farmers to select seed of any small grain in the field. The field agents were engaged in this work throughout the harvest season and through their efforts large amounts of seed were carefully selected, properly dried, and stored.

An illustrated poster was prepared and the text printed in English and Spanish, as well as in five of the leading dialects (Plate XII). Altogether, ten thousand posters were sent out and posted in public buildings, such as provincial and municipal government headquarters, public markets, railroad stations and other places where the people congregate in numbers. Posters were also distributed to the public schools throughout the Islands to the number of 4,300. These were all in the English language.

The Director of Education, Mr. Frank L. Crone, sent instructions to the division superintendents of schools, to the effect that "The information contained therein (on the posters) should be taught to the pupils as a part of their regular work." Some division superintendents responded with enthusiasm and even went so far as to lay out a definite course of instruction, based on the poster, to be followed by the teachers. One instance is on record where eight lessons were arranged to be given each class so that the subject matter would be thoroughly mastered.

Preceding the planting season of 1915 a rice-demonstration train was sent through the principal rice-growing territory. (Plate XIII, *a*.)

This train consisted of a passenger coach, remodeled so as to provide means for properly displaying seeds, photographs and charts. Farmers were invited to bring samples of their seed rice to this coach where a trained man would meet them and discuss the merits of the samples and other varieties. A flatcar was attached to this coach and on it were mounted engines and pumps designed for small irrigation plants (Plate XIII, *b*). Plows, harrows, cultivators and other small implements were also carried and actual field operation of each demonstrated (Plate XIII, *c*). In the evening an illustrated lecture was given on the subject of improvements of rice culture.

This outfit made a stop of a whole day at each place and traversed the principal rice-producing regions and received approximately 30,000 visitors on the tour.

Prior to the planting season the demand for seed of early maturing varieties of rice, made upon the Bureau of Agriculture, was far beyond its ability to supply, but approximately 5,000 farmers secured varying quantities of seed for planting. It was also deemed essential to secure a more comprehensive test of the four new pedigree varieties which had been evolved and several hundred farmers volunteered to give them a trial.

At the time this is being written harvest reports are coming in which amply prove that the confidence placed in these new strains has been justified and that they are regarded with keen appreciation by the growers. In one strain we have found a remarkable stiffness of straw and in another a habit that is quite as valuable. This other strain when blown down by high winds promptly proceeds to put the panicle in an erect position so that the grains are less likely to be damaged by the flood water.

Interest in seed selection is growing to such an extent that the field agents now find much of their time taken up during the harvest season by the farmers who desire to be shown how to select their seed rice for the next planting. Many of these farmers have seen the value of this work demonstrated before their eyes in a manner which leaves no room for doubt. This office has emphasized the importance of good seed and has given this topic precedence over all others, due to the fact that the poor and unsuitable seed ordinarily planted contributes more than any other factor to the poor average yields obtained in the Philippines.

Another point to be considered is the fact that the average farmer is averse to making radical changes in his methods, nor is he in a position to purchase fertilizers, but by using better seed he can produce much larger crops, without upsetting any of the usual practices.

A very small percentage of the rice lands are under irrigation, and little of the remainder can be irrigated except through large and expensive plants, which are beyond the means of the land owners, unless such projects are supported and directed by the Government.

This office has as yet done but little work on the problems involved in the fertilization of rice soils. With a small force it is better to do one thing at a time, attacking the most vital problems first.

Considerable study has been devoted to the subject of the proper distance at which to space hills of seedlings in the field, the proper number of seedlings to put in each hill, the age at

which seedlings should be transplanted, and the area of seed bed to be used for a given amount of seed.

Uniformity of practice with regard to the details mentioned above does not prevail here, as in China, for instance. Practices differ widely in neighboring districts, and the prevalent tendency is to space hills too closely and to put too many plants in the hill. Usually the seedlings are left in the seedbed too long.

In the opinion of the writer, plot testing with varieties which are subjected to "mass selection" as Dr. Nilsson uses the term, are of importance principally as a means of keeping a fresh stock of seed on hand and a possible source of an occasional remarkable mother plant.

With us, it is cheaper to carry a considerable number of these varieties in plot culture than it would be to go out searching for the variety whenever it might be desired. The varieties now carried may serve another purpose as well, for, being the best varieties remaining out of several hundred, their combined records are a yearly check with which we can compare the performance of the new lines. We are constantly on the watch for the exceptional mother plant. Every man engaged in rice work is repeatedly admonished, to look for such plants at all times.

We are not planning to go into hybridization work in the immediate future, since we have a wealth of undeveloped or uninvestigated material which may yield lines far surpassing anything hoped for. In fact, we are confident that within at least one of the so-called varieties from which we have already extracted a superior strain we shall find material for a still better one.

The line-breeding work, begun by the writer with rice, has been adapted from the methods employed in the amelioration of cereals and other cultivated plants at the Svalöf Experiment Station in Sweden.

Since we had the plot tests of varieties planted with but one seedling in the hill, the selection of mother plants was a simple matter, compared with making selections of plants in fields where a number of seedlings were set in the hill. It is preferable to run a sharp cutting instrument just beneath the surface of the soil to sever the roots so that the entire plant may be removed. Pulling the plant frequently results in injury. If a careful inspection is made of the kernel beforehand, but few plants need to be taken which are likely to be discarded later. Each plant is subjected to a careful scrutiny and when it is to be retained for a mother plant, it is given a permanent number,

and the panicle on the central culm removed and placed in a small envelope, numbered to correspond with the plant. The plant is then accurately described and all data pertaining to it recorded in a permanent file. This data should be sufficiently in detail so that, if the plant is damaged or destroyed, a sound basis for comparison is still to be had.

With lowland rice there need be little doubt about the uniformity of the fertility of the soil of the test plot since a plot of 25 x 25 meters is easily made and the soil can be thoroughly mixed and reduced to a uniform condition, and the plot made so level that uniform distribution of water will be insured. We have used plots 10 x 25 meters in interior dimension, and with proper precautions the use of plots of this size need not increase the probable error. Our preference is for plots with a surplus margin of 50 to 70 centimeters as a border next to the dikes on which extra plants may be grown to be discarded at harvest time. Thus if the line of 100 plants has three extra plants properly spaced on each end and is the fourth row from the dike, the influence of position near to dikes will not be apparent. Usually it is the two outside rows which benefit by the preferred position next to dikes.

At harvest time the entire row is harvested excluding of course the plants at the ends of the rows. Each plant has a band of raffia tied about it and is severed from its roots at the surface of the soil. All the plants of the row are tied into a bundle and the row marker (a stake) is included therein. After the curing is completed each bundle in turn is spread out for inspection. A comparison made with the data concerning the mother plant or with the mother plant itself, usually indicates the probable value of the line. Quite frequently, this cursory view is sufficient to determine the fact that the mother plant has not produced progeny even remotely resembling itself in productivity and the line is set aside forthwith.

If the line passes the first test, the heads of each plant are snipped off at the base of the panicle and placed in a standard envelope. Then all the envelopes with contents are weighed, the tare subtracted and the net weight divided by the number of plants in the line. It may be well to number the plants with easily attached labels and the envelopes to correspond so as to avoid any confusion which may arise due to clumsy handling, but if the work is done in an orderly systematic manner the numbering may be omitted.

The test by gross weight usually disposes of a majority of the lines. Those that pass this test will have the envelopes con-

taining the panicles attached to the respective plants and will then be subjected to the careful scrutiny, measurements and counting that is necessary to find the modes and a basis for consistent comparison.

The first year's work with the lines does not afford a good opportunity to observe their performance when subjected to high winds. We have not devised laboratory equipment to test the breaking strength of straw, and regard the field test as more dependable, on account of the several factors involved.

For the second year we have employed a method which some regard as unnecessarily comprehensive. From the lines which are finally retained, the central panicle is taken from twenty plants thereof which are usually above the mode for the essential characters. The remainder of the seed from these twenty plants is mixed together and constitute a primary check sample. The seed from the remaining plants is taken and mixed together and constitutes a secondary check sample. Thus in the second year the mother plant is represented by a unit of twenty rows of 100 plants each; each of these rows represents one of the twenty supernormal plants of the first line, a primary check plot in duplicate being planted with a composite sample of seed from these plants and a secondary check plot in duplicate being planted with a composite sample of seed from remaining plants of the original line. The figures which result from this triplicate system of checking, if properly done, leave little chance for making any serious mistake in the final choice of lines. If there is any doubt about the merits of a given culture it may be carried in the plot test, so as to avoid losing the seed, until such time as the doubt is settled.

During the second year a good opportunity is afforded to observe such things as stiffness of straw, and tolerance of dry, hot weather. After the second year, the cultures should be on such a large scale that the hectare yields may be based on sufficiently large units to obviate the frequent errors which result in compiling yields from small plots.

In our experience, we have pushed the propagation of the most promising lines so that at the end of the second year we have on hand a considerable quantity of seed. If then the second year's work proved the correctness of the theory based on the first year's work, an area of several hectares might be planted in the third year.

We have several supporting facts behind us in proceeding in this maner. To begin with, the mother plants are taken from mass cultures of which we have a dependable record for a period

of 3 to 6 years and the margin of difference between the average yield of the plots of mass selections and the yield of the line cultures frequently amounts to the astonishing figure of from 50 to 200 per cent. Thus if the duplicate plots of the mass-selected culture yields an average of 0.75 kilos per 100 plants and the line cultures yield double or treble that amount, there is little chance in making serious mistakes in choice. Another very important feature is the permanent elimination of the kernels with colored cuticle, not to mention the uniformity of ripening and other features. Even though no gain in productivity should result the other improvements are worth far more than the effort and expense incurred.

Regarding the so-called new varieties it is our preference to withhold final judgment until they have been grown in large cultures for not less than five years. For the immediate future, however, we feel justified in being less conservative.

Another feature of the rice work in 1915 was the arrangement entered into by the plant-industry division of the Bureau of Agriculture with some of the students of the Central Luzon agricultural school, for the purpose of having pure seed rice propagated on an extensive scale. This school is known as a farm school and in it besides the academic work the students are obliged to labor on the school farm.

A considerable body of the school boys were divided into two classes; one known as the Special Rice Growers and the other body as the Independent Farmers. Each of these classes has elected a secretary who is the representative of the class in its relations with officials of the Bureau of Agriculture.

Improved seed in quantity was furnished the boys who agreed to grow the crop according to instructions with which they were supplied.

Through their secretary each class submits monthly reports on progress of work and status of the various rice varieties which reports are always acknowledged by the Director of Agriculture or the chief of the plant-industry division, sometimes asking for more detailed information or offering comments.

It is understood that when the rice crop is ready for sale the Bureau of Agriculture will purchase it at a premium above the market price, since the grain will be handled in such a manner as is most suitable in the treatment of high-grade seed.

The school boys have entered into the business with keen interest and even though the odds have been against them at times, they have striven valiantly to overcome them.

At one time, while the rice plants were quite young, locusts

appeared and threatened to destroy the miniature rice farms, but the principal of the school, appreciating the seriousness of the situation, declared a holiday and the entire schoolbody went against invading locusts and managed to save the rice with but little damage.

When these students who have been carefully cultivating this rice crop make delivery thereof to the purchasing agent of the Bureau of Agriculture, they will be paid therefor as would any other businessman in a transaction of this nature, and this money is the student's to keep or to spend for such things as he requires in his school work.

The rivalry between the two competing bodies is wholesome and effective and the interest in varieties which is created leads to criticism of their respective merits which leaves little to be desired.

MYRTACEOUS POSSIBILITIES FOR THE PLANT BREEDER.

By P. J. WEBSTER, *Horticulturist in Charge of Lamao Experiment Station.*

PRELIMINARY REMARKS.

In an article published in this REVIEW last year by the writer, a brief survey was made of the plant material available for plant improvement in the Tropics, and attention was called to the excellent opportunities for original work for the plant breeder in the equatorial belt.[1] Going more into detail, another article was previously published in this REVIEW enumerating and briefly describing 49 species belonging to the family *Annonaceæ* that may be utilized in plant improvement work.[2] In that paper the writer stated that "it is doubtful whether there is any other genus which contains so many species having edible fruits as the genus *Annona,*" enumerating 21 species of that genus with edible fruits, and recognizing a total of 31 edible species in the family *Annonaceæ.*

Since then a bibliographical study of the myrtaceous plants has brought to light the astounding fact that this large family contains no less than 64 species with edible fruits, of which 20 belong to the genus *Psidium* and 19 to *Eugenia,* with scattered species in 13 other genera.

While pains have been taken to exclude all doubtful species and synonyms, it is nevertheless probable that a comparative study of the European and American herbaria would establish the synonymy of some of the species hereinafter enumerated. On the other hand, it is practically certain that if more complete data were available relative to many species not included in this list, and the descriptions of which are anything but complete, they would, in all likelihood, be classed among the fruit-bearing plants, not to speak of still unknown species of which

[1] "Opportunities in Plant Improvement in The Tropics;" see this REVIEW, Vol. VII (1914), No. 3, p. 123.

[2] "Annonaceous Possibilities for The Plant Breeder;" see this REVIEW, Vol. VI (1913), No. 7, p. 312.

there must be many in the vast, unexplored Brazilian hinterland. In the botanically comparatively well-known Philippines two edible Eugenias have been described within the last four years. (*E. curranii* C. B. Rob. and *E. calubcob* C. B. Rob.)

Of the genera under discussion, some, like the *Eugenia,* extend over the Tropics in both hemispheres, and several species of this genus were therefore known and described by the early European travelers in the East. Other genera, like *Britoa* and *Psidium,* are confined to the American Tropics and subtropics. It is true that some species of *Psidium* have been reported from Asia, but it is safe to say that these species had been previously introduced there from America. Brazil is the home of more species belonging to the *Myrtaceæ* (46) with thremmatological possibilities than any other country; Australia contributes one species.

Commercially the most important species is unquestionably *Bertholletia nobilis* Miers., as the source of the Brazil nut, but as soon as the virtues of the sapucaia become better known we may expect this to rival the Brazil nut. The most important among the fruits is the guava, which is also the most widely distributed species. A close second to the guava in value is the jaboticaba, and, judging from the most recent account of this fruit, the jaboticaba, when better known, and introduced into other parts of the Tropics, will, in the future, take a prominent rank among the tropical fruits. The feijoa is also a fruit of unusual merit, the cultivation of which is rapidly spreading in southern France and California.

The guava, strawberry guava, cattley guava, feijoa, macopa, duhat, yambo, pitanga and jaboticaba are the only species in cultivation, for all practical purposes, though, as may be noted in the descriptive list, there are several others that have been more or less domesticated. The guava, pitanga and feijoa are the only ones that have been propagated vegetatively, until recently it was demonstrated at the Lamao experiment station that the duhat, yambo and lipoti could be shield budded.

The fact that three of the species—jaboticaba, lipoti and duhat—are used in the manufacture of wine, coupled with the fact that grapes do not thrive well in the Tropics except at high altitudes, brings up the interesting speculation as to whether we may not among the *Myrtaceæ* find desirable substitutes for the grape for the Torrid Zone, principally, of course, for a wine industry, but also as a dessert fruit. In Brazil the jaboticaba is used for both purposes. Considering that three are used for wine making, it seems certainly probable that among so many

related species there are several others that also would possess wine-making qualities.

Broadly speaking, the annonaceous fruits, because of their large sugar and starch content, are valuable as an actual food, in contrast to the myrtaceous fruits, which, with the exception of the Brazil nut and the sapucaia, find their chief uses as dessert fruits, or in the manufacture of preserves and jellies.

The notes used in the preparation of this article, which has been prepared with a view of calling the attention of horticulturists and breeders to the available plant material among the myrtaceous plants, were collected in 1910 in Washington, D. C., when the writer was connected with the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, but lack of time to put them into printable shape has until now prevented their publication. Unfortunately the available descriptions of the fruits of a large number of species in the botanical literature consulted are very incomplete, frequently merely stating that the fruit is edible.

DESCRIPTIONS AND COMMENTS.

1. *Aulomyrcia obovata* Berg.—An arborescent shrub, indigenous to Brazil, attaining a height of 6 meters, bearing small, dark purplish, subacid, 1–4 seeded, edible fruits.

2. *Bertholletia nobilis* Miers.—Brazil nut. A tall tree, exceeding 33 meters in height, indigenous to tropical Brazil and Guiana; fruit almost spherical, 9 to 12 centimeters long, consisting of a hard shell containing 18 to 24 three-angled nuts.

Bertholletia excelsa H. B. K. was formerly considered as a source of the Brazil nut, but this has recently been shown to be an error.

3. *Britoa acida* Berg. (*Psidium acutangulum* DC.).—A tree, 6 to 9 meters high, indigenous to the interior of Brazil along the upper Amazon River; fruit quite large, of the size of a small apple, spherical, pale yellow, smooth, with acid pulp.

4. *B. sellowiana* Berg.—Casacas. A tree attaining a height of 6 to 8 meters or more, native of Brazil; fruit 2 centimeters in diameter, subglobose, yellowish, and edible.

Closely related to the guava.

5. *B. triflora* Mart.—Ibabiraba. A tree, indigenous to tropical Brazil, with a fruit of about the size of a cherry, brownish; flesh whitish and edible.

6. *Campomanesia aromatica* Griseb. (*Psidium aromaticum* Aubl.).—Citronelle. A small tree, 4.5 or more meters tall, indigenous to the West Indies and Guiana; fruit of about the size of a cherry, spherical, yellowish, aromatic and edible.

7. *C. coerulea* Berg.—A small shrub, 1 to 2 meters tall, with glaucous foliage and edible fruits, indigenous to Brazil.

8. *C. corymbosa* Berg. (*Psidium corymbosum* Cambess).—Guabiroba. A small, erect shrub, 1.5 meters tall, native of Brazil; fruit rotundate, yellowish and of good flavor.

9. *C. fusca* Berg.—An arborescent shrub, 5 to 6 meters tall, with edible fruit, indigenous to Brazil.

10. *C. lineatifolia* Ruiz et Pavon. (*Psidium lineatifolium* Pers.).—Palilla. An arborescent shrub, attaining a height of 4 meters, indigenous from Brazil to Peru, in which latter country it was already in cultivation 100 years ago; fruit 3.5 centimeters in diameter, pyriform, yellow and edible.

11. *C. multiflora* Berg. (*Psidium multiflorum* Cambess).—A small, erect shrub, 1 meter tall, with an edible fruit, native to Brazil.

12. *C. obversa* Berg.—An arborescent shrub, 6 meters in height, indigenous to Brazil, bearing edible fruits.

13. *C. reticulata* Berg.—An arborescent shrub, indigenous to São Paulo, Brazil; fruit about the size of a cherry, yellow, aromatic and well flavored.

14. *C. transalpina* Berg.—A tree, bearing a well-flavored fruit, indigenous to Brazil.

15. *Eugenia aquea* Burm.—Tambis. A small tree with turbinate, frequently seedless, edible fruits; indigenous to Indo-Malaysia, including Mindanao in the Philippines. Sometimes cultivated.[1]

16. *E. brasiliensis* Lam.—Grumichama. An arborescent evergreen shrub, attaining a height of from 4 to 6 meters, native of Brazil; fruit about 2.5 centimeters in diameter, spherical to oblate, crowned by a prominent persistent calyx, exterior dark red to purple, smooth and shining; flesh sweet and of agreeable flavor.

The grumichama is rarely seen outside of Brazil.

17. *E. calubcob* C. B. Rob.—Calubcub. An arborescent shrub or small tree, attaining a height of 6 to 8 meters, indigenous to the Philippines; fruit ellipsoid to ovoid, greenish white, fleshy and edible.

18. *E. curranii* C. B. Rob.—Lipoti (Plate V, *a*). A tree, attaining a height of 9 meters or more, with gnarled trunk and tortuous branches, evergreen; fruit congregated in clusters on the branches and mature twigs; individual fruits, 12 to 20 millimeters in diameter, spherical, smooth, dark red to black; skin very thin; flesh red next to skin, interior white, rather dry, crisp, acid and of pleasant flavor. Indigenous to the Philippines where it is rarely cultivated. Season April to June.

Eaten raw and used in making a wine by the native inhabitants.

19. *E. dysenterica* DC.—Cagateira. A shrub, 1 to 5 meters tall, or a tree, with edible, lemon-colored fruits, native of Brazil.

20. *E. gardneriana* Berg.—A shrub, 2 meters high, or a tree, with dark-red to blackish fruits, edible. Indigenous to Brazil.

21. *E. guabiju* Berg.—Guabiju. A tree, attaining a height of 6 to 9 meters, bearing an edible fruit, indigenous to Brazil.

22. *E. itacolumensis* Berg.—An arborescent shrub, 4.5 meters tall, with

[1] The writer is indebted to Dr. E. D. Merrill, Botanist, Bureau of Science, for descriptions of *E. aquea*, *E. mananquil* and *L. zabucajo*.

ovoid, 2 centimeters long, one-seeded, edible fruits. Indigenous to Minas Geraes, Brazil.

23. *E. jambolana* Lam.—Duhat. A large, spreading tree, attaining a height of 8 to 15 meters; leaves oval to elliptic or obovate elliptic, leathery and shining; flowers numerous, in panicles, axillary or terminal; fruit ovoid to ellipsoid, 1.5 to 2.25 centimeters long, dark purple to black, smooth, thin skinned, fleshy, juicy, subacid, well flavored, and containing one seed.

The fruit makes a superior jelly. The duhat is indigenous to the eastern Tropics and is as yet only sparingly introduced in other parts of the Tropics. A wine is prepared from the duhat in India.

24. *E. jambos* L.—Yambo. An arborescent shrub, or a tree, sometimes attaining a height of 12 meters, indigenous to Malaysia; leaves lanceolate, dark green, leathery and shining; fruit 2.5 to 4 centimeters in diameter, ovoid to spherical, cream colored, smooth; flesh sweet and crisp, dry and well flavored, with a peculiar odor and aroma of roses, which has in some parts of the Tropics given the fruit the name "roseapple" or "poma rosa."

The fruit may to advantage be used in flavoring jelly and related products made from other fruits. The yambo is fairly well introduced into the West Indies, but is less common on the mainland of the Western Hemisphere.

25. *E. javanica* L.—Manquil. A tree, attaining a height of 12 meters; leaves elliptic-oblong, subsessile, dark green. The fruit is 3 to 4 centimeters long, turbinate, smooth, pinkish and very attractively colored; the flesh is white, dry, sweetish, without distinctive flavor, tasteless and of poor quality.

The manquil is without doubt the "waterapple" figured in Plate IX, in "Fruits of the Hawaiian Islands" by G. P. Wilder, who states that in Hawaii the fruit of this species attains the remarkable length of 12.5 centimeters. The manquil is indigenous to Malaysia and is but sparingly introduced into other parts of the Tropics.

26. *E. klotzschiana* Berg.—Cabacinha. A small shrub, 1 to 2 meters tall, indigenous to Brazil, with an edible fruit of the size of a small pear.

27. *E. malaccensis* L.—Macopa. An attractive tree, attaining a height of 10 to 12 meters, with elliptic-oblong to broadly oblong-lanceolate, dark green, coriaceous leaves, indigenous from India to Malaysia, but fairly well introduced in the West Indies and Hawaii. The fruit is subglobose to obovoid, 3 to 4 centimeters long, smooth, dark red; flesh white, subacid, and pleasantly flavored, but rather dry and of inferior quality.

28. *E. mananquil* Blanco.—Midbid. A sylvan, tall tree, 7 to 20 meters high with prominently veined leaves, indigenous to the Philippines. The fruits, borne in great profusion on the trunk and large branches, are about 4 centimeters long, ovoid, red, fleshy, acid and edible.

E. whitfordii Merr. is a closely allied form of *E. mananquil.*

29. *E. myrtifolia* Sims.—A shrub, 2 to 4 meters tall, native of Australia.

The fruit is about 1.8 centimeters in diameter, red or violet colored and edible.

Seldom seen outside of its native country.

30. *E. nhanica* Camb.—Nianica. A tree, indigenous to Minaes Geraes, Brazil, with a fruit about the size of a medium-sized prune, red, smooth, shining, edible, 1 to 4 seeded.

31. *E. pyriformis* Camb.—Uvalha. A small tree, native of São Paulo, Brazil. The fruit is of about the size of a prune, pyriform, yellow, velvety, edible.

32. *E. uniflora* L. (*E. michellii* Lam.).—Pitanga. A shrub, indigenous to Brazil, attaining a height of 6 meters, with ovate-lanceolate, glabrous leaves. The fruit is 2.5 centimeters in diameter, sub-globose in outline, deeply ribbed longitudinally, dark red, to almost black, smooth and shining; flesh juicy, subacid and of good flavor, resinous when not thoroughly mature.

Comparatively rare outside of Brazil.

33. *E. uvalha* Camb.—Uvalha. A shrub, native of São Paulo, Brazil, where it is cultivated. The fruit is pyriform, of the size of a small pear, yellowish, acid and well flavored, and 1 or 2 seeded.

34. *Feijoa sellowiana* Berg.—Feijoa. A bushy shrub, attaining a height of 3 to 4 meters, with obtusely elliptical leaves, thick and leathery, dark green and shining above, grayish and puberulent beneath, flowers axillary, solitary or in clusters. The fruit is 4 to 6 centimeters long, oblong or ovoid, green, surface smooth, furrowed longitudinally, rough, skin thin; flesh white, granular, sweet, juicy, highly aromatic, and of excellent flavor and quality, seeds very small, embedded in the flesh.

The Feijoa is indigenous to Southern Brazil, Paraguay, Uruguay, and Northern Argentina, and has been introduced to Southern France and Italy, Hawaii and the West Indies. It is a fruit of unusual promise, but is subtropical rather than tropical, and will probably succeed only at high altitudes in the Tropics.

35. *Gomidesia sellowiana* Berg.—A shrub, sometimes exceeding 3 meters in height, indigenous to tropical Brazil. The fruit is small, globose, scarlet, sweet and edible, 1 to 4 seeded.

36. *Lecythis zabucajo* Aubl.—Sapucaia. A tree, 25 meters or more high, with oblong-lanceolate, entire, acuminate leaves, and terminal pendulous racemes of white and pink flowers. Fruit ovoid, about 15 centimeters in diameter, containing numerous furrowed nuts about 5 centimeters long and 2.5 centimeters across. Indigenous to Guiana and adjacent territory in Brazil.

37. *Marlieria tomentosa* Camb.—Guapuronga. A shrub, indigenous to São Paulo, Brazil. The fruit is of about the size of a cherry, black, tomentose, and of good flavor.

38. *Myrciaria jaboticaba* Berg.—Jaboticaba. A spreading tree, attaining a height of 10 to 12 meters, with ovate-elliptical to lanceolate leaves, native of Central Brazil. The fruit is produced on the stem, branches and twigs, not unlike the Philippine lipoti, 12 to sometimes exceeding 25

millimeters in diameter, spherical or slightly oblate, dark maroon purple, glossy and smooth, skin thicker than that of the grape, tough; flesh white or tinged with rose, translucent, vinous, and of good flavor, seeds 2 to 4.

The jaboticaba was known to Piso and Marcgrav, and has been domesticated in Brazil, where the fruit is very popular, and where the tree is cultivated to some extent. The fruit is eaten out of hand, and fermented makes a good wine. Two other species of *Myrciaria, M. trunciflora* Berg. and *M. cauliflora* Berg., are known under the vernacular name "Jaboticaba." These species present minor differences from each other and from *M. jaboticaba,* and when closely studied all will probably be included as varieties of a common species.

39. *M. tenella* Berg.—Macia. A shrub, 2 to 4.5 meters in height, indigenous to tropical Brazil extending to subtropical South America. Fruits small, globose, dark purple, fleshy, subacid and well flavored, 1 to 2 seeded.

40. *Myrhinium atropurpureum* Schott.—Murtilla. A shrub, native of Brazil, bearing ovoid, 2 to 4 seeded, edible fruits.

41. *Myrtus mucronata* Camb.—A small shrub, 1 meter tall, with spherical, polyspermous, edible fruits of the size of the cherry, indigenous to Northern Argentina, Uruguay, and Southern Brazil.

42. *M. ugni* Molina.—Ugni. A tree, attaining a height of 30 meters, indigenous to Chile. The fruit is purple, glossy, edible, and of agreeable flavor.

43. *Psidium arboreum* Vell.—A tall tree, indigenous to Brazil, with solitary flowers and pyriform, well-flavored fruits, 2.5 centimeters in diameter.

44. *P. basanthum* Berg.—A dwarf shrub about 30 centimeters tall, native of Brazil. The fruit is globose, 2 centimeters in diameter, greenish and edible.

45. *P. cattleianum* Sabine. (*P. obovatum* Mart, ex DC., *P. littorale* Raddi, *P. variabile* Berg., *P. coriaceum* Berg.).—Cattley guava. A shrub or small tree, attaining a height of 6 meters, with dark-green, leathery, shining leaves, indigenous to Brazil. The fruit is subglobose, up to 3.5 centimeters in diameter, claret red, smooth; flesh reddish near skin, interior white, juicy, subacid, sweet, aromatic and of good flavor, seeds many, small.

The cattley guava is quite hardy, and is cultivated to a considerable extent in California and is also grown in Florida and South Europe. The yellow cattley guava (*P. c.* var. *lucidum* of some writers) should perhaps be raised to the rank of a separate species.

46. *P. cinereum* Mart. ex DC.—A shrub, native of Brazil, bearing an ovoid edible fruit.

47. *P. cuneatum* Camb.—A shrub, indigenous to Brazil. The fruit is about 2.5 centimeters in diameter, pyriform, greenish, glabrous, punctate; the flesh is of good flavor and contains few seeds.

48. *P. dulce* Vell.—A tree, native of Brazil, with solitary, spherical fruits, 3.5 centimeters in diameter; flesh sweet and edible.

49. *P. firmum* Berg.—A small shrub, 30 centimeters tall, with edible, subglobose to ovoid fruits, native of Brazil.

50. *P. friedrichsthalianum* Ndz.—Cos. A tree, indigenous to Central America, attaining a height of 8 to 12 meters; the fruit is small, subrotund, very acid, and is said to make a superior preserve and jelly.

51. *P. grandifolium* Mart. ex DC. (*P. albidum* Camb.).—A shrub with large, obovate leaves, glabrous above; the fruit is 3 centimeters in diameter, globose, greenish, almost glabrous, the flesh is well flavored. Indigenous to Brazil.

52. *P. guajava* L. (*P. fragrans* Macf., *P. aromaticum* Blanco, *P. cujavillus* Burm., *P. sapidissimum* Jacq., *P. pyriferum* L., *P. pomiferum* L.).—Guava. An arborescent shrub, attaining a height of 6 meters, indigenous to Tropical America. Leaves oblong to elliptic with prominent veins, flowers axillary, 1 to 3, white. Fruit variable, spherical to obovoid and pyriform, from 3 to 7.5 centimeters in diameter, greenish yellow to almost white, smooth, skin very thin. Flesh extremely variable in all characteristics, in color from pure white to various shades of yellow and red, in acidity and sweetness from very sweet to extremely acid, or to lack of both, resulting in an insipid, flavorless fruit; in good varieties the flesh is juicy, tender and excellently flavored. The seeds are usually numerous, but seedling trees are found now and then that are almost seedless.

The guava is one of the most widely distributed of the tropical fruits, readily adapts itself to new soil and climatic conditions, and usually naturalizes itself wherever introduced. The fruit makes a very superior jelly and canned fruit, and a good guava makes an excellent dessert fruit eaten with sugar and cream.

53. *P. guineense* Sw. (*P. araca* Raddi, *P. dichotomum* Weinm.).—Araca. A shrub, indigenous from the West Indies to Brazil. The fruit, produced 1 to 3 in the axiliary buds, is 1 to 2 centimeters in diameter, subrotund, greenish yellow, sparsely pubescent, flesh variable in color, red to white, and of excellent flavor.

According to Martius the araca is the Aracá-iba of Piso and Marcgrav, and was cultivated in Santo Domingo, West Indies, as early as 1788. Nevertheless, and notwithstanding its excellent quality, the araca is still rare in cultivation.

54. *P. incanescens* Mart. ex DC.—A shrub, indigenous to Brazil, upwards of 2 or more meters high; the fruit is about 2.5 centimeters in diameter, subglobose, green, and of good flavor, containing 4 to 5 seeds.

55. *P. microcarpum* Camb.—A small shrub, native to Brazil, with subrotund, greenish fruits, 1.2 centimeters in diameter, of good flavor.

56. *P. molle* Bertol. (*P. monticolum* Berg.).—Guisaro. A small shrub, indigenous to Central America and Mexico. The fruits are small, seldom exceeding 18 millimeters in diameter, spherical, smooth, yellowish; the flesh is yellowish white, juicy, rather acid, of excellent flavor, and quite aromatic.

57. *P. montanum Sw.* (*P. cordatum* Sims., *P. amplexicaule* Rich., *P. aromaticum* Desc.).—A tall tree, sometimes attaining a height of 30 meters, with hard wood and rigid branches, growing from sea level to an altitude of 1,800 meters. The flowers are large, white and fragrant, and the fruit

of about the size of a cherry, globose, greenish, pubescent, aromatic and of good flavor.

P. montanum is indigenous to the West Indies, and was domesticated as early as 1816 in the islands of Guadeloupe and Saint Croix. Still it is even yet seen sparingly in cultivation even in the West Indies, and is very rare in the eastern Tropics.

58. *P. ovoideum* Berg.—A dwarf shrub, upwards of 1 meter high, with greenish-yellow, edible fruits, indigenous to Brazil.

A very variable species.

59. *P. pohlianum* Berg.—A plant with ovoid, yellowish, glabrous, edible fruits, 2 to 2.5 centimeters in diameter, indigenous to Brazil.

60. *P. polycarpon* Lamb.—A small shrub, rarely exceeding 1 meter in height, indigenous to tropical America. Many-flowered; the fruit is of the size of a large cherry, yellow, of delicate and good flavor.

61. *P. radicans* Berg.—Uvaca. A small, erect shrub, with an edible fruit, native of Brazil.

62. *P. suffruticosum* Berg.—A shrub, 2 to 3 meters tall, indigenous to Brazil, with subglobose, green fruits, 2 centimeters in diameter, edible.

63. *Rhodomyrtus tomentosa* Wight.—A shrub, 2 meters or more tall, indigenous to the southeastern mainland of Asia. The fruit is about 2 to 2.5 centimeters in diameter, globose or ovoid, dark purple, flesh sweet and aromatic and well flavored.

This species has been sparingly introduced into the West Indies.

64. *Rubachia glomerata* Berg.—Cambuca. A tree, indigenous to Brazil. The fruit is of the size of an apricot, yellowish, 1 to 2 seeded and edible.

The cambuca was in cultivation in Rio de Janeiro over fifty years ago, but seems never to have been introduced abroad.

CORN IMPROVEMENT IN THE PHILIPPINES.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

In 1910 it was estimated that 288 thousand hectares of corn were cultivated in the Philippine Islands, returning an average yield per hectare of 8.56 cavanes.

The figures for 1914 show 421 thousand hectares devoted to corn and an average yield of 14.87 cavanes per hectare, an increase in area of 46 per cent and an increase in yield per hectare of nearly 74 per cent.

These large increases are significant, especially the marked improvement in yield per hectare, particularly when the fact is known that the increase in yield has not been influenced in the slightest degree by the introduction of foreign varieties, but has been effected solely by the improvement of native varieties, and the practice of better cultural methods.

The figures gathered by the statistical division of the Bureau of Agriculture show steady advancement in area cultivated, and yield.

Fiscal year.	Area cultivated, hectares.	Average yield per hectare.
1910	288,268	8.56
1911	302,516	8.22
1912	340,196	10.78
1913	383,709	11.31
1913 [a]	394,648	12.55
1914	421,309	14.87

[a] Calendar year.

This steady progress is encouraging, but it is realized that only a beginning has been made. The highest average yield of 14.87 cavanes per hectare does not compare favorably with the average annual yield obtained in the United States, which is 29 cavanes per hectare for a forty-five year period.

The extension of the area devoted to corn culture is due to several causes: for example, the two droughts which have cut down the production of rice, which has in turn caused the farmers to plant corn more extensively as a secondary crop; the education of the people in the methods of preparing corn for

human consumption; the realization too, that corn is fit and proper for such purposes; and, as a direct response to the interest shown by the Government in the extension of corn culture.

One of the great obstacles to overcome has been the prejudice of the people who have been so long under the domination of the European idea that corn is fit only for feeding animals. This attitude finds expression in apologies offered when corn in some form is set before the guest, the inference being that the host is at least tacitly admitting poverty when he fails to provide rice.

This attitude is less frequently encountered now, as the people are learning that corn is both a wholesome and proper food for all classes of humanity.

On two of the densely populated islands of the Archipelago, the people have become corn eaters, since natural conditions have forced this situation upon them.

In the selection of varieties, color prejudices on the part of the farmers are met with as frequently here as in other parts of the corn-growing world. The more common contention is that yellow corn is more nutritious than white.

Another prejudice which for a while was not as carefully heeded as it should have been is the farmer's strong preference for a strictly flinty type of kernel. This preference is quite justifiable when it is remembered that the greater bulk of the crop is consumed as human food, the kernels cracked or made into "grits" and then cooked in much the same manner as rice. Any variety of corn which contains a considerable portion of soft starch is not so suitable for making grits, since in the cracking process the soft starch crumbles, and is finally sifted out and can be utilized only for feeding animals. Very many people who buy corn for food have no animals to consume this waste. In addition, it has been found that the softer dent varieties are preferred by the weevils, hence are damaged by them more quickly and completely.

Corn is grown throughout the year, provided there is sufficient moisture present in the soil, and the same strain or variety which is planted at the beginning of the rainy season is also planted toward the end of the rainy season.

Consequently, it will be readily seen that extremely different demands are made upon the same variety. When the corn is planted at the beginning of the rainy season, it is subjected to the maximum rainfall and minimum sunshine, but when it is planted towards the end of the rainy season the crop is subjected to a limited rainfall with ample sunshine.

Anyone who is familiar with the requirements of the corn plant

will anticipate that maximum yields of corn will be produced from the planting made toward the end of the rainy season, and this is actually the case. Surprisingly satisfactory results, however, are frequently secured when the crop is grown under less favorable conditions.

The most prevalent error in culture is overcrowding, so that normal development is prohibited. Over-crowding has its support in the belief that the more plants on the hectare the more grain will be produced, and besides that, the ground will be shaded sufficiently to retard weed-growth.

A practice that very materially reduces corn yield in the Philippines is the same one that is so persistantly adhered to in all corn-growing countries, namely, deep plowing instead of shallow cultivation, after the root systems are well developed. This destructive mode of cultivation is practiced in the culture of sugar-cane and tobacco, as well.

In seed selection the Filipino farmer frequently puts into practice a very good principle. He insists that a seed kernel should have a large "chit" or germ.

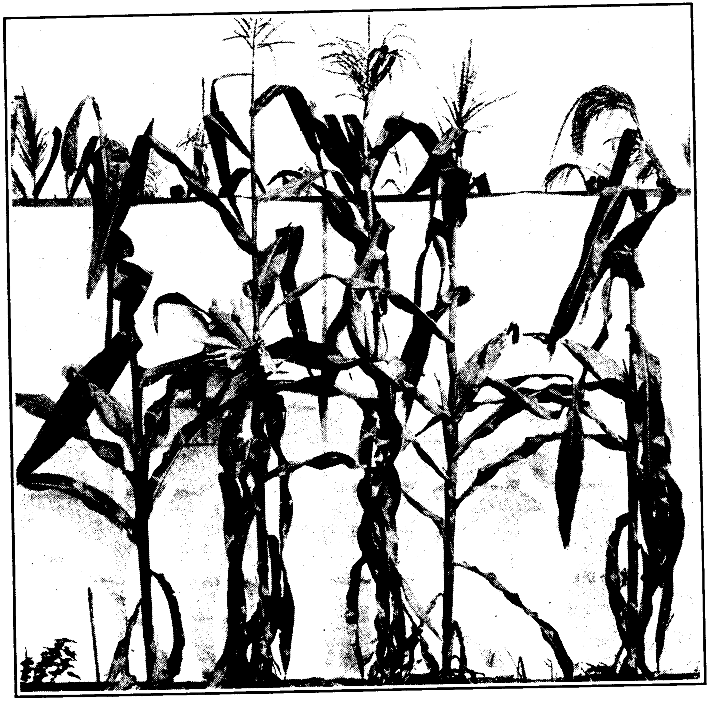
It is interesting to note in this connection, that the farmer has unconsciously selected a strain of corn which has tended to have a high protein content. According to Professor Willard, in Kansas Experiment Station Bulletin No. 197, it is quite possible to secure a high average protein content if large germs are selected, especially if the horny portion of the kernel is also large. Selecting seed with large germs also tends to increase the oil content, as has been shown by Dr. Hopkins of Illinois.

The following analyses made by the Bureau of Science show the composition of several types of Philippine corn.

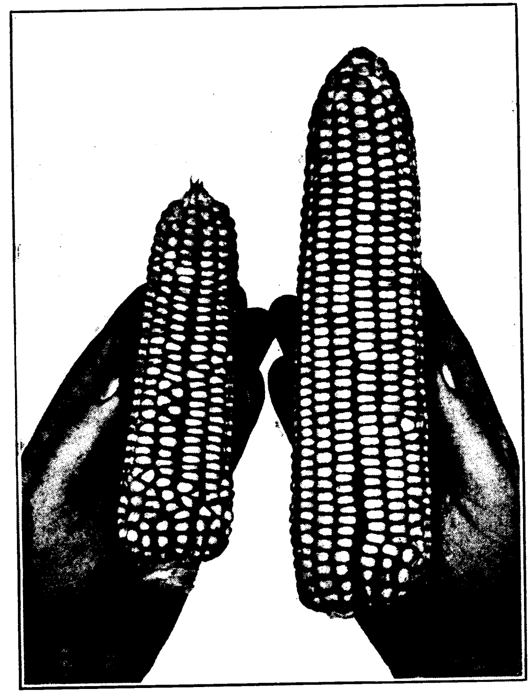
Name.	Moisture.	Fat.	Carbohydrates.	Protein	Ash.	Crude fiber.
Laguna Yellow	11.34	4.96	72.91	7.96	1.20	1.63
Mexican June	11.46	4.94	71.52	9.28	1.46	1.34
Moro	11.60	4.81	69.76	10.50	1.54	1.79
Cebu Purple	11.00	4.38	71.61	10.17	1.03	1.81
Cebu White	11.50	4.42	70.94	9.45	1.73	1.96
Iloilo Yellow	11.69	4.89	73.18	7.88	1.33	1.03
Iloilo White	11.32	5.96	70.55	9.10	1.53	1.54

Analyses which have been made of American dent varieties have shown relatively low oil and protein content, though the evidence on hand is not conclusive. The Philippine native varieties are as a rule very similar in composition to the flint corns grown in the United States.

Some isolated regions have produced distinctive types of corn so that in a fertile valley a large type may be found, while in an



(*a*) Representatives of the types found in a good culture in an ear-to-the-row test. First generation.



(*b*) A selected ear from a common strain of native white corn compared with a selected ear from the fourth generation of native white corn improved by means of systematic seed selection. Both ears were derived from identical stock.

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PLATE XV.

(*a*) A distinctive type of native white corn. Note the slender stalks and general lack of vigor.

(*b*) Another type of native white corn after being improved by ordinary selection methods. Note the thick, short-jointed stalks, large broad leaves and generally vigorous appearance, in contrast to the type shown in (*a*).

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Native white corn. These are representative specimens from apparently homozygous strains produced by self-pollination in two generations.

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upland country when the soil is poor a very small variety is cultivated.

As has been found in the United States, the highest production is usually secured with locally produced seed. It will also be found here, that with considerable differences in climate and soil fertility, it will be most profitable to develop local varieties of corn.

Native corn produced at 6° north latitude has apparently been insensible to the change, when moved north to 16° north latitude. This experiment has been repeated several times with no marked change taking place in the variety. On the other hand, but a slight change in enviroment has, in other experiments, produced unsatisfactory results.

American and Mexican varieties have at times behaved very strangely during the first season's culture, as is to be expected. Thus a variety planted at the beginning of the rainy season would prolong its growing period and become extremely rank, but if planted in the dry season would hasten to maturity and not even remotely reach its normal development. This is equally true of so-called Australian varieties.

The Mexican June variety of corn was introduced in 1908 and was successfully grown. While it did not "break up" as many introduced varieties do, it soon became quite different from the type it represents in the United States and in the course of five years became as flinty as the least flinty native varieties.

Since the native varieties produce the desired quality of grain, and are besides able to survive in varying and, at times, rather unfavorable environment, a thoughtful person would hesitate to throw away or disregard them. It is quite probable that these varieties, being largely the result of "the survival of the fittest," have a high degree of disease resistance and this factor is of paramount importance.

The chief criticism to be made on the native varieties is low productivity.

In the belief that the native varieties could be rapidly improved in the direction of productivity the writer began systematic selection work in 1912 and from that time up to the present no further attempt has been made to introduce foreign corn varieties. (Plate XIV, *a, b*).

In 1912 and since then extensive distribution has been made of seed of the larger and more productive types or varieties of native corn, which has undoubtedly had a marked effect in raising the average yield per hectare.

The first ear-to-the-row experimental plot was planted Decem-

ber 21, 1912. The seed ears selected were of the large-type white native variety. Large well-shaped ears only were taken but of two general shapes. One shape conformed as nearly as possible to the cylindrical while the other was distinctly tapering.

Sixty seven per cent of the seed ears had 16 rows of kernels, 25 per cent had 18 rows and the remainder had 20 rows of kernels. The number of kernels per row ranged from 36 to 45.

The longest ear measured 22.8, and the shortest, 20.3 centimeters. The circumference of all ears was taken at a point one-third of the distance from butt to tip and the greatest circumference was 18.4, and the smallest 16.5 centimeters.

The highest percentage of shelled corn on any ear was 84, the lowest 64. The average for the cylindrical shape was 81 per cent, and for the distinctly tapering 75 per cent.

In the field the rows were spaced 1.25 meters apart, and two kernels placed in each hill, spacing the hills 0.4 meter apart. Twenty days after planting the weaker plant was removed from each hill.

During the vegetative period the weeds were kept down by shallow cultivation and hand hoeing.

The first tassels appeared 54 days after planting and the first silks 57 days after planting.

The earliest maturing row required 88 days, and the latest maturing row 100 days.

All rows had an abundance of suckers as was anticipated, since the soil was moderately fertile and in good condition, and the plants given ample space, namely, 0.5 square meter each.

Data was taken on a large number of points, of which only a few are given here, because of lack of space.

Before harvesting, among other things observations were taken as to the point of attachment of the ear to the stalk and the following table giving the data taken on six rows selected at random throughout the plot is representative:

Row.	Node at which ear was attached.					
	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
A	4	22	52	22	0	0
B	4	31	43	20	2	0
C	2	28	51	19	0	0
D	2	17	36	37	8	0
E	1	11	42	41	4	1
F	8	31	44	15	2	0

As a general thing when the ear was borne at the sixth node, it was approximately on the middle of the stalk. This was the

case even though the internodal lengths varied considerably. Even on plants with short internodes, when the ear was attached at the seventh node, it was at such a height that the weight of the ear combined with the increased leverage caused the stalk to be more easily blown down.

Further data was taken and the figures given below fairly represent the variations found:

Row.	Sterile stalks.	Plants with one ear only.	Plants with two or more ears well developed.	Yield per hectare secondary ears.	Total yield.	Average weight per ear (primary).	Weight of seed ear.
	Per cent.	*Per cent.*	*Per cent.*	*Kilos.*	*Kilos.*	*Grams.*	*Grams.*
A	00.00	52.27	19.32	246	2,337	170	327
B	1.02	70.41	18.37	308	3,262	240	327
C	.96	69.57	7.62	80	2,125	166	272
D	0.00	40.78	28.16	410	3,080	217	272
E	0.00	40.26	33.77	472	2,756	186	288
F	0.00	37.76	29.53	288	2,960	217	302
G	2.65	35.40	23.89	434	2,488	167	272
H	0.95	34.95	12.26	118	2,593	201	802
I	0.00	69.72	12.75	78	2,778	219	295
J	0.00	43.75	44.79	111	2,694	210	303
K	0.00		54.00			196	319
L	0.00	14.38	64.71	750	3,920	258	288

It is estimated that 2.47 cavanes of ear corn will yield one cavan shelled corn; therefore, using 75 kilograms as the unit weight for one cavan, the yield expressed in cavanes ranges from 31 to 52 hectare.

The secondary ears, though mostly nubbins, yielded a percentage of shelled corn ranging from 63 to 75 per cent.

The most surprising result was the difference in yield when the product of the cylindrically shaped seed ears was compared with the product of the tapering seed ears. The latter yielded 25.9 per cent more shelled corn. This result is obviously due to several contributing causes. Williams and Welton, in Bulletin No. 282 of the Ohio Agricultural Experiment Station, show that "As an average of the 9 years' tests the tapering ears have been found to be 1.65 bushels per acre in the lead."

The chief fault with ears which were most cylindrical in shape was the bareness of the tip—an entry for several sorts of destructive insects. The tapering ears tended to have well-covered tips.

Seed ears for further planting were selected from three cultures, namely, "B", "F", and "L" and planted ear-to-the-row on April 9–10, but the rows were placed more closely than in the preceding test, namely, 1 meter apart, spacing the kernels so as to provide 0.36 square meter for each plant.

The increased yields are in part attributable to the closer spacing. The soil on which the crop was grown was in good

physical condition and well supplied with plant food, though not heavily fertilized.

Comparing the average yields of the seed ears according to the mother ears from which they were derived we find that "B" yielded 76.4 cavanes per hectare as an average of all cultures, "F" 96.2 and "L" 90.5. It should have been stated before that as a rule stout, short-jointed stalks of an average height of 3 meters, bearing broad leaves, were typical in all cultures. (Plate XV, *a, b.*)

This type of plant was particularly sought when the seed ears were selected.

While the above experiment was under way production tests under high culture were made, planting standard duplicate plots of $\frac{1}{25}$ hectare in area. On these the yields were 83.3, 118.9, and 151.2 cavanes per hectare, respectively, for each series. These plots were heavily fertilized, intensively cultivated and irrigated at regular intervals. This test was made in order to learn the extent to which production could be pushed in growing native corn.

In each ear-to-the-row test the half of each row was detasseled, alternating the ends. Thus the west half of row No. 2 was detasseled and the east half of row No. 3.

In the latter part of 1913 systematic production of seed of improved native corn was begun on one of the experiment stations, the plan being to plant a given area each month the year around. This was very successful and it became possible to obtain fresh seed corn with a high degree of viability at all times. In the Tropics, the germinating power of corn appears to be quite easily lost.

On the station selected for seed growing the weather conditions are more uniform than in many other places, the rainfall being distributed over a longer period, so that in a normal season it is possible to successfully plant one field and harvest another field of corn each month. The drought this year, however, was so severe that it was impossible to conserve sufficient moisture in the soil to germinate the seed during the hot season. It is usually possible on this station to see corn at all stages of growth from the newly planted to the mature corn ready for the drying kiln.

In a general way, the results obtained in the ear-to-the-row tests have been substantiated by the results obtained by agricultural inspectors in the field, by plantation managers and by others, who have found that by practicing seed selection in the

field, the yield of native corn has been rapidly and very markedly increased.

It is a common impression that the improvement of corn is a very simple and easy proposition, but that is true only in a relative degree. Because of its gigantic size when compared with other grain-producing plants it is easier to realize the differences in the individual characteristics of the corn plant. But, when one considers the infinite complexity of the genetic formula of a plant that is habitually cross-fertilized and hence hybridized to an extreme degree, it is exceedingly difficult to foresee the probable outcome of any selection and crossing that may be made. Especially is this true of a variety of corn which is the result of haphazard treatment through innumerable generations.

The most that the corn breeder who employs present accredited methods can hope for is to group similar types or strains, so that by continued grouping and crossing of similar individuals, the desired characters become emphasized to such a degree that the representative factors dominate in the genetic formula.

That this is the actual result is readily shown in any systematic breeding experiment. Frequently, in the most uniform and productive row there are a number of quite unlike and unproductive plants, and, as the work proceeds the proportion of these is lessened, but even with our purest strains of corn, unlike and unproductive plants occur with alarming frequency.

With corn, due to the stimulus of hybridization, a strain may appear to be much superior in some respects than it actually is. This is particularly true regarding size and productivity, but these characters are easily lost as soon as the genetic formula is again changed, as it usually does, in each generation.

The farmer who has been taught that "like produces like" is sorely puzzled when the progeny of a particularly fine plant presents as much variation apparently, as the progeny from a "scrub" plant.

The complexity of the corn plant is more easily realized when several of them, by means of self-pollination, are reduced to a more nearly homozygous condition, and with the object in view of obtaining more constant and definately known types for foundation stock for breeding work, five hundred ears of white native corn were collected as a portion of our corn work from various points in the Archipelago, and each ear planted in a row by itself. (Plate XVI.)

Roguing was begun early, and as a result, at the end of six weeks 20 per cent of the cultures were eliminated. At the time

that tassels were due to appear the range of variation presented was extremely large. One thousand plants were selected for self-pollination. The self-pollination was accomplished by means of a paper tube attached over the tassel and the other end of the tube fastened over the ear, employing the method described by G. N. Collins and J. H. Kempton, Bureau of Plant Industry, circular No. 89.

Only 124 cultures were retained for further planting, but shortly after these cultures were planted it became necessary to abandon the experiment, still general observations were made from time to time which disclosed striking features.

As to tassels, in some cultures they were very small with few branches, and in others the tassels were of unusual size and had profuse branches. Leaves varied greatly in color, size and position; on one culture the leaves clasped the stalk through their entire length, merely releasing the tips. The husks on the ears ranged from few in number to an excessive amount and on some the husks terminated in fully developed blades. Some cultures showed a purple color in a high degree.

Several cultures were remarkable in uniformity of all characters indicating a high degree of purity.

It is to be regretted that conditions did not permit the completion of this experiment since it would have supplied known parents of definitely known characters for the production of several distinct strains of native corn.

There has been little effort made to do research work with corn, as yet, since in the opinion of the writer, Collins, East, Hayes, Montgomery, Williams and others have supplied the corn-breeding world with ample scientific data so that progressive breeding work can be done intelligently.

Our problem here has been to find a suitable variety of corn, one that would be equal to the demands made upon it by local conditions, and that would be profitably productive. This has been done. It has been amply proven that almost any native type of corn can, by means of selection alone, if the work is progressively and intelligently done, be improved in productivity and quality to such a point that it will compare very favorably with improved corn varieties in other corn-growing countries.

Furthermore, progress will be more rapid in the adoption of better seed by the farmers since this sort of improved seed does not in any manner conflict with the farmers' prejudices. It conforms to his idea of color and composition and is in all respects similar to the seed he has been planting, but it has never-

theless greater productivity and consequently its future culture is assured.

It has been found easily possible to introduce and acclimatize a foreign variety of corn. In fact it takes no longer to acclimatize the foreign than it takes to improve the native sort, but unless the introduced variety has most of the good qualities of the native it will not be favorably received by the farmers. A multiplicity of varieties is quite undesirable in any crop in any community, and the danger of plant disease introduction, as an accompaniment of foreign seed introduction, is very real and ever-present. Therefore, it is the opinion of the writer that until the purpose and object of plant introduction is clearly seen, the amelioration of native varieties by selection is the most logical and safest course to follow in crop improvement, and, with only few exceptions, should be the policy of those who are entrusted with the work.

A YEAR OF AGRICULTURAL ORGANIZATION IN THE PHILIPPINES.

By MACK CRETCHER, *Superintendent of Coöperative Organization.*

In the campaign for advancement of agricultural conditions carried on through the office of coöperative organization of the Bureau of Agriculture during the past year, three great forces have been recognized. They are: Organization, agricultural education, and coöperation, and they follow each other in regular sequence. Organization is necessary in order to properly conduct a campaign of education leading to coöperation or united action on the part of the farmers.

Agricultural conditions in the Philippines are peculiar. Farmers are isolated. Mail and transportation facilities, although gradually improving, are as yet grossly inadequate. Lack of uniform language has retarded unity of thought and action. The average farmer has little or no knowledge of the principles of coöperation. He has been struggling with his problems unaided and alone. It is little wonder that in the majority of instances the methods employed are antiquated and the results often disappointing and discouraging.

Realizing the benefits of organization and the needs of agricultural education and coöperation, Honorable H. S. Martin, Secretary of Public Instruction, early in the year of 1914 initiated a campaign for uniting the farmers of the Philippines in an organization known as the Philippine Agricultural Society. The plan included the organization of a provincial or governing society in every province in the Islands, the membership to be composed of representative farmers from the municipalities of each province. Under the direction and supervision of these provincial agricultural societies, municipal agricultural societies were to be organized in each municipality. After the completion of this preliminary work, an Insular Agricultural Society was to be formed, its membership to consist of regularly accredited delegates from the various provincial societies. To facilitate the work of organization, the office of Coöperative

Organization was created in the Bureau of Agriculture, and Honorable Monico Mercado, ex-delegate from Pampanga, and the writer, were appointed as superintendents. During the month of June 1914 the preliminary steps were taken, including the drafting of tentative constitutions and by-laws to be used as a guide for the Insular, provincial and municipal societies, and the arrangement of an itinerary covering the leading provinces of Central Luzon. Copies of the constitutions and by-laws were printed not only in English and Spanish, but were also translated and printed in the leading provincial dialects, the more clearly to make known the objects of the proposed organization.

The first actual work of organization was begun with the organization of the Provincial Agricultural Society of Tayabas, which was perfected at Lucena, in that province, on July 7, 1914. Following this in rapid succession during the month of July, provincial agricultural societies were organized in the Provinces of Batangas, Laguna, Rizal, Cavite, Bulacan, Nueva Ecija, Pampanga, Tarlac, Pangasinan and Bataan, concluding with the organization of a society at Iba, Zambales, on July 31. The work was continued during the month of August 1914. The coast-guard cutter "Corregidor" was chartered and a tour of the southern provinces was arranged. During this trip agricultural societies were organized in the Provinces of Palawan, Capiz, Iloilo, Occidental Negros, Oriental Negros and Cebu. At Cebu, owing to an unfortunate accident to the engine of the coast-guard cutter, the boat was compelled to return to Manila for repairs and the remainder of the southern schedule was abandoned for the time being, except the Provinces of Albay and Ambos Camarines, which were reached by regular boat after returning to Manila, in time to attend meetings on the dates previously arranged. The society at Naga, Ambos Camarines, was organized August 25, 1914, being the last one for that month and the 20th society formed since the organizers started out on their work on July 7. The organizers met with the hearty support of the agriculturists in every province visited. The meetings were well attended and there was much interest and enthusiasm. Probably the largest meeting held was at Dagupan, Pangasinan, where 44 out of a total of 46 municipalities had representatives at the meeting which was held July 25. The total attendance was more than 450 interested farmers.

Upon returning to Manila from the southern organizing trip, the work having been well started, Mr. Mercado resigned his position as one of the organizers in order to give his entire atten-

tion to his law practice, and the work has since that time been continued by the writer, at times assisted by Honorable Adriano Hernandez, Assistant Director of the Bureau of Agriculture.

The work of organizing municipal agricultural societies occupied much of the time during the next few months. This work was done largely by the newly-elected officers of the provincial societies, under the direction of the office of coöperative organization in the Bureau of Agriculture. Copies of the constitution and by-laws, blanks for secretary's reports and instructions concerning organizing municipal societies were forwarded to the officers of the provincial agricultural societies and they were urged to at once take up the work of thoroughly organizing their provinces. The results were highly satisfactory. The unselfish, patriotic work of many of these officials deserves the highest commendation. They gave freely of both their time and their money in furthering the work. Some of the officers of the provincial societies visited every municipality within their jurisdiction, delivered lectures to the people, explained the benefits of the new movement and assisted in organizing the farmers in each locality. As a result, the office of coöperative organization was kept busy tabulating the reports of municipal organizations as they came in. By the end of November, 1914, over 150 municipal agricultural societies had been reported, and by January 1915 the total had increased to over 200. All this work was done by the provincial societies and their active officials at their own expense, as up to the present writing no money whatever has been received by any of these societies from the General Government.

As fast as the reports of these organizations were received they were entered in the permanent records of the office of coöperative organization, card indexed and alphabetically arranged by provinces, for ready reference. From time to time during the year the work of provincial organization has been extended, personal visits having been made by the superintendent to the Provinces of Samar, Leyte and Bohol, where provincial societies were established, and through correspondence and personal aid of leading agriculturists and officials, societies have been formed in the Provinces of Surigao, Mindoro, Masbate and Ilocos Norte.

A summary of the work of organization up to the time this article is written (September, 1915), a period of but little over one year, shows a total of 27 provinces in which provincial agricultural societies have been established, and under the direction of these parent organizations there are 265 municipal or branch

societies, the total membership exceeding 20,000. This membership is limited to persons who are actively engaged in the vocation of agriculture. This is the record of the year's accomplishment in organization. Naturally, interest follows in the educational and coöperative results obtained through this organization.

The educational work has been carried on by lectures given by officers of these societies at regular and special meetings. From time to time members of the Bureau of Agriculture and others have delivered lectures to the societies. It is estimated that over 40,000 farmers were reached by the exhibit, demonstration and lectures of the successful "Rice-special" trip this season, a 45-day tour over the lines of the Manila Railway.

Commencing in November, 1914, a market report containing a summary of Manila prices on standard farm products such as rice, copra, abacá (Manila hemp), sugar, tobacco and live stock, has been compiled weekly and a copy has been mailed promptly every week to the president of each provincial and municipal society for the guidance of the members in marketing their farm products. A weekly cable report of New York sugar prices has been received and promptly forwarded by wire to the leading sugar-producing provinces.

In the month of January, 1915, the publication of the Philippine Farmer was commenced, a monthly periodical devoted to practical farm topics. It is printed in English and Spanish and is sent free to every member of the Philippine Agricultural Society.

The writer has personally visited as many of the societies as the limited time at his disposal permitted, and has delivered talks on coöperation and assisted in every way possible in maintaining interest in the organization. Acting Director Hernandez, the chief of the demonstration division of the Bureau of Agriculture and the field men of the Bureau have aided in the educational work by holding special meetings in which educational work in seed selection, soil preparation, methods of planting, irrigation, cultivation, the use of modern implements, preparation and marketing of products, and of the spirit of coöperation and united action, has been carried forward with marked success.

Although the work of these newly-organized societies during the past year has necessarily been largely educational and will probably be of that nature for some time to come, yet the results of agricultural education and even ventures along coöperative lines are apparent. In the Food-production Campaign of last

year, although the societies were in their infancy, they were an important aid in increasing production of secondary food products all over the Islands. The president of the Provincial Agricultural Society of Albay states that although the recent prolonged drought was so severe that in many places 80 per cent of the abacá (Manila hemp) crop was ruined, the price of food products did not advance, due to the excellent work of the agricultural societies in conducting the food-production campaign.

Coöperation was apparent in the Province of Tayabas during the recent campaign against bud-rot in the coconut groves. Meetings of the societies were held, lectures were delivered, and active support was given by the members to the enforcement of the strict measures of the Bureau of Agriculture for the suppression of this destructive disease.

In Pampanga, the provincial society has been very active in laboring for the welfare of the farmers of the province. The officers of the society have held important conferences with the officials of the Manila Railway Company and were successful in securing better train service, equipment, etc., and many times during the last session of the Legislature made known the wishes of Pampanga farmers on important legislative matters.

In Iloilo, the president of the provincial society states that there is a demand for selected seed by farmers from every municipality in the province, a condition heretofore unknown in the history of the province. He attributes this largely to the activities of the agricultural societies and to information obtained by reading the society publication, the Philippine Farmer.

Agricultural inspectors, fiber inspectors and field men of the Bureau generally, report that the societies have been of assistance to them in their field and demonstration work.

In many municipalities the farmers hold their meetings in the home of some member of the society where the farm paper is read regularly and translated into the local dialect, and the topics are discussed and much valuable information is obtained.

In several localities, members of the society have bought live stock, community owned, for the purpose of improving the herds of the members. The animal-husbandry division of the Bureau of Agriculture receives many communications every week along this line.

Members of the society in Tarlac and other provinces have pooled their interests in irrigation projects, the coöperative plan proving very satisfactory.

In several localities coöperative stock corporations have been formed and shares offered to members on the plan of paying for

the same in regular monthly installments, thus adding a savings feature to that of coöperative business. This idea is exemplified fully in the society known as the Lipa Young Farmers' Association, a branch of the Lipa, Batangas, Municipal Agricultural Society. This society, as its name implies, is composed of young farmers. It has a membership of over 40, the shares have a par value of $5 each and each member must own at least one share. The company is organized to deal in improved live stock and conduct a general agricultural business coöperatively.

In the Province of Albay a big two-days special meeting or congress was held during the past year. Addresses were made by the provincial governor, the lieutenant governor, by lawyers, doctors, the third member, the president of the provincial agricultural society, the provincial delegates and many others of prominence.

Another event in which the organized farmers of the Islands played a prominent part was the Farmers Congress held in Manila, August 21 to 28, 1915. This great meeting was called upon the initiative of Honorable Manuel Quezon, resident commissioner, and the members of the Economic League, a Manila organization. Members of the Philippine Agricultural Society were well represented at this meeting and helped in every way possible to make it a success. Nearly 500 delegates attended, representing nearly every province in the Archipelago. Addresses were made by leading officials of the Government, by educators, commercial men, leading farmers, and Bureau specialists. The members of the various committees worked earnestly and intelligently on the difficult tasks assigned them, and the result of their labors as outlined in the 34 resolutions adopted on the last day of the meeting was highly creditable. In the selection of the officers of the congress, the organized farmers were fully recognized, as every officer is a member of the Philippine Agricultural Society. The president of the congress, Mr. Matias Gonzalez, is president of the Provincial Agricultural Society of Pangasinan. The first vice-president, Mr. Gregorio Yulo, is president of the Iloilo provincial society. General Alejandrino, of the Pampanga society, is second vice-president. Mr. August Gonzalez, secretary of the congress, is the secretary of the Pampanga provincial society, and Mr. Carlos Locsin, of the Negros provincial society, is also a secretary of the congress, these two secretaries also acting as treasurers.

The active participation of the Philippine Agricultural Society in the deliberations of the Farmers Congress, and the pronounced success of the congress itself, are matters of congratu-

lation, but the calling of the congress at the particular time it was held seriously interfered with one plan of the Philippine Agricultural Society, that of the organization of an Insular Agricultural Society. The Farmers Congress so carefully covered all Insular matters of an agricultural nature and brought so many of the leading farmers into conference, that it was not deemed expedient to attempt the organization of an Insular Agricultural Society until some later date. When this work is accomplished together with the addition of provincial organizations in the few remaining provinces, the organization will be complete. It is the first effort at organization on so large a scale ever attempted in the Philippines.

The record of accomplishment in one short year speaks for itself. The society is as yet in its infancy but the results obtained are encouraging and prove the wisdom of the adoption of the plan of organization. Success has by no means been attained in every case. Some of the societies that were enthusiastic at the start, have grown indifferent and results in these instances have been negative. It is a constant struggle to keep interest alive, to keep the societies on their feet and moving. There have been discouragements along with the small measure of success attained during the first year of agricultural organization in the Philippines. The fact that some progress has been made is encouraging. There is justification in the belief that through organization, education and coöperation faithfully upheld in the years to come, great improvement will be made in agriculture, for with these three forces properly directed will come increased production, better systems of marketing, lower interest rates and more extended irrigation systems, increased revenues for schools and transportation, more comforts, and less grinding toil, relief from present isolation, more self-reliance, a new viewpoint of the dignity of farming as a vocation, happy homes and a prosperous and contented people. The attainment of these conditions could hardly be expected in one year of organization, education and coöperation. But a start has been made. The way has been opened. It leads straight to prosperity. The ultimate success necessarily rests with the farmers themselves. If they become indifferent, their condition can hardly be expected to improve. If they continue to show a willingness to progress as they have done in a majority of the provinces during the past year, the road to success is plain.

BOOK REVIEW.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

PRACTICAL WHITE-SUGAR MANUFACTURE.

One of the latest books on the subject of sugar to reach this Bureau bears the above title. It is from the pen of the eminent sugar technologist, Dr. H. C. Princen Geerligs.

There is a growing interest in the production of high-grade sugars directly in the plantation factory, which eliminates the expensive boneblack process of the refiners, thus placing the sugar planter and manufacturer in a more independent position.

There are a number of well-established methods in use for this work, and each year brings forth numerous other methods, many of which contain advanced ideas worthy of consideration. This new book briefly summarizes the better systems now in use, and passes comment on the good and bad points in each.

The book is divided into three parts, the first of which deals with cane-juice clarification, treating respectively of the principles of clarification, defecation, carbonitation methods, special methods, and the advantages of the different clarification processes. Part two deals with boiling, curing and storing of white sugar, while part three treats of the different materials employed in the manufacture of plantation white sugar.

This book may well be considered as the most authentic treatise now extant on the subject of white-sugar manufacture, and will be welcomed by sugar planters throughout the world.

It may be obtained from Norman Roger, 2, St. Dunstan's Hill, England, price 12 shillings.

CURRENT NOTES—THIRD QUARTER.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao Experiment Station.

NOTES FROM HAWAII.

Fruit analyses.—The annual report of the Hawaiian agricultural experiment station for 1914 contains much information of interest. One of its most valuable contributions is an article on the "Composition of Hawaiian Fruits and Nuts," by Alice R. Thompson.

Miss Thompson gives the analyses of 47 species of fruits and nuts, and of several varieties of avocados, mangos, bananas, and papayas. As is well known, the fat content in the avocado varies greatly in the fruit from different trees, averaging from 12 to 16 per cent of the entire fruit. One of the avocados analyzed gave the remarkably high fat content of 21.79 per cent.

With the recent discovery of a practical method of propagating the seedless breadfruit on a large scale, the analysis of this valuable fruit assumes particular interest to those living in the Tropics, as the bread-fruit is one of those fruit trees that is already paramount in the sustenance of the population in some of the archipelagos in the Pacific Ocean, and has remarkable climatological adaptability. That it is so little used in most of the Torrid Zone is due partly to ignorance of its virtues and partly to the difficulty of its propagation herefore. With both these obstacles removed we may in the future expect to see large areas devoted to breadfruit culture throughout the Tropics, particularly with the dissemination of the reputedly superior varieties from the Marquesas Islands, which are said to have more than two score different kinds.

In the analysis made in Hawaii the breadfruit was found to have a considerably higher food value than the banana, with considerably less waste. The edible portion in the banana varied from 64.29 to 75.72 per cent, while in the breadfruit from 77.75 to 83.44 per cent. The protein and fat content averaged about the same in both fruits, while the total sugar in the breadfruit ranged from 9.49 to 14.60 per cent, in the banana varying from

14.49 to 26.20 per cent. The starch in the banana was at most 2.57 per cent against 9.27 to 27.89 per cent in the breadfruit.

Rubber.—Last year the writer suggested in this periodical [1] that the time would come when rubber plants would be propagated asexually, as a result of selection and breading. It appears from the above report that this suggestion was anticipated by two years by Mr. W. A. Anderson, superintendent of the rubber substation at Nahiku, Maui, Hawaii, and his is in all probability the first attempt to vegetatively propagate a rubber plant with the definite object in view of increasing the yield of rubber. The cuttings were made in 1912 from selected Ceara rubber trees and tappings were made from the resultant trees in 1914 with indications that "this method of propagation can be successfully employed to transmit desirable latex-yielding properties."

Roselle.—The roselle crop of Maui (one of the Hawaiian islands) in 1914 was valued at ₱105,600, grown on 88 hectares—a gross return of ₱1,200 per hectare—the roselle being grown chiefly as a secondary crop between the rubber, and the calyces dried and exported. The following is quoted verbatim from the report, the measurements having been reduced to the metric system:

> The rubber trees among which the roselle was planted were spaced 3 to 6 meters. The roselle was accordingly planted 1.5 by 1.5 meters as the most convenient spacing to utilize the soil in conjunction with the trees. This is rather close planting where the bushes grow as large as in the Nahiku district. In the early plantings on the lower elevations the plants grew to a height of 2.4 to 3 meters bearing the fruit rather too high for convenient picking. These plants yielded, however, at the rate of 4.5 kg. per plant, or roughly, 16,800 kg. per hectare among the rubber trees. With the same yield per plant, and the rubber plants replaced by roselle we should have had over 19,000 kg. per hectare, which is a larger yield than has been elsewhere reported.

This extraordinary yield was grown with a rainfall of 2,729 mm., probably fairly equally distributed throughout the year.

Since roselle has been found profitable in Hawaii with labor at not less than ₱2.00 per day, it would seem that it should also be profitable in the Philippines where labor averages, at most, 75 centavos per day.

Mesquit meal.—The use of mesquit meal, the ground pods of the mesquit, *Prosopis juliflora,* or algaroba, as it is called in Hawaii, for stock feed is rapidly increasing throughout the Hawaiian Islands, the annual consumption now being valued at

[1] "Opportunities in Plant Improvement in The Tropics." See this REVIEW, Vol. VII (1914), No. 3, p. 123.

₱700,000. This plant, introduced into Hawaii ninety years ago, grows largely on waste land, and does not occupy any of the agricultural land. The tree is of rapid growth, a very valuable source of honey, and makes good firewood. Thousands of hectares of unoccupied land in the Philippines could probably to great advantage be planted to this tree.

Papaya.—Considering the ease with which the papaya can be grown in the Philippines, the statement in the report that papain can be produced at a profit of ₱5 per pound (0.45 kg.) should be of great interest to the Philippine agriculturist. The experiments in Hawaii indicate that papain to the value of ₱4 can be obtained annually from one papaya plant. "It has been found that the papain is injured if the juice is allowed to come in contact with any metallic substance. The only precautions to be observed are that tapping be done with a glass, bone or ivory instrument, and that the juice be collected in china or earthenware containers and promptly dried."

SUBSTITUTES FOR LEMONADE.

Always appreciated in a warm climate, lemonade or limeade or similar drinks from other citrus fruits are not everywhere obtainable, but good substitutes may be produced from the fruits of certain other trees and plants. Quite accidentally the writer found recently that an excellent beverage, which we may call mangoade, can be made from inmature mangos, and that it is quite equal to lemonade in its refreshing qualities, though of course differing in flavor. Mangoade is prepared thus: peel, slice and rinse unripe mangos, and boil in enough water to cover the fruit; strain the mass through a fine cloth and cool; when serving, add sugar and water to taste.

By planting seed from time to time throughout the year, roselleade may be had at a very slight expense at all times of the year.

Roselleade is made as follows: Cut the leaves and tender stems, rinse, and put in a kettle with enough water to cover the herbage after it is wilted, bring to a boil, strain and cool. Serve as mangoade.

In both cases great care should be taken to boil and keep the liquids in earthen, granite enameled ware or glass in order to avoid poisoning caused by the contact of the strong fruit acids with metals.

Ripe tamarinds may be made into a delicious cooling drink that is unsurpassed in flavor, and also they make unusually

well-flavored jelly. The iba, *Cicca disticha,* may also be utilized in making what may be called "ibaäde" of very good flavor, and doubtless, the camia, *Averrhoa bilimbi,* and other acid fruits could be employed in a similar way.

CALAMONDIN OR KUMQUAT?

Three years ago the Bureau of Agriculture imported from Australia budwood of what purported to be the kumquat, *Citrus japonica.* The resultant plants made good growth and one plant has already yielded two crops of fruit, and this year bloomed heavily for the third time. When the first fruits ripened the writer was struck by the similarity of the fruit of the alleged kumquat and the native calamondin, *Citrus mitis,* and therefore made careful comparisons between all parts of the two plants, including the flowers, with the result that the two were found to be indentical in every respect.

The "sour" kumquat, described by Hume in "Citrus Fruits and Their Culture," is also in all probability the calamondin parading under another name.

THE SEEDLESS MABOLO, A NEW FRUIT FOR THE TROPICS.

Among the less well-known tropical fruits that are commonly propagated from seed, the mabolo is the first species to permanently contribute to tropical pomology a seedless fruit of greatly improved quality. The writer had for more than three years heard of the existence of seedless mabolos, but largely for the reason that nothing was known as to whether or not the mabolo could be propagated vegetatively the matter was left in abeyance. During the past dry season experiments were made at Lamao that yielded very satisfactory results and it was found that the mabolo is readily shield budded. (See Current Notes in the preceding issue of this Review.)

For a description of the mabolo as ordinarily found in the market consult the preceding issue of this Review. The ordinary mabolo is of rather poor quality, and notwithstanding its size and attractive appearance it has never gained the favor of the European. The seedless fruit is oblate, sweet and juicy, and of good flavor, absolutely coreless and without seed. In other words, as in the banana, the entire fruit is edible, the thin skin excepted, and altogether it is a very superior fruit that is sure to gain popularity. According to the owner of the trees 80 per cent of the fruit is seedless, the remainder containing from one to three seeds.

VEGETATIVE PROPAGATION OF TROPICAL FRUITS.[1]

Experiments in vegetative propagation of tropical fruits have been continued at the Lamao experiment station, as a result of which "propagation recipes" are given relative to the following species:

Barbados cherry, *Malpighia glabra.* Use petioled, light gray to greenish, mature budwood; cut the buds 3.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Casimiroa, *Casimiroa edulis.* Use petioled, fairly mature, greenish budwood; cut the buds 3.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Catmon, *Dillenia philippinensis.* Use fairly mature, dark green or purplish, smooth, petioled budwood; cut the buds 3 centimeters long; age of stock at the point of insertion of the bud unimportant.

Duhat, *Eugenia jambolana.* Use barely mature, green or reddish, smooth, petioled budwood; cut the buds 4 to 4.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Genipap, *Genipa americana.* Use mature, bluish-green, smooth, non-petioled budwood; cut the buds 4 to 4.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Jujube, *Zizyphus jujuba.* Use mature, grayish, tomentose, petioled budwood; cut the buds 3.5 to 4 centimeters long; age of stock at the point of insertion of the bud unimportant.

Ketembilla, *Aberia gardneri.* Use petioled, preferably spineless, not too old budwood with tomentum still present; cut the buds 3 to 3.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Nelli, *Phyllanthus emblica.* Use mature, greenish brown, petioled budwood; cut the buds 3.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Phalsa, *Grewia asiatica.* Use mature, brownish, petioled, tomentose budwood; cut the buds 3.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

The Muscadine grape, *Vitis rotundifolia,* including the Scuppernong, Labama, Mish, James, Thomas and several other varieties, in southern United States is usually propagated by means of layering, but it has been found that hardwood cuttings inserted in sandy soil under half shade during the dormant season take root easily. Make the cuttings about 25 to 30 centimeters

[1] See also this REVIEW, Vol. VIII (1915), No. 2, page 135.

long, with two to three buds, and insert $\frac{2}{3}$ to $\frac{3}{4}$ of the cutting in the soil so that one bud is just above the soil. Pack the soil well around the cuttings.

Lanzone, *Lansium domesticum.* This species has proved to be one of the most difficult subjects that the writer has handled, and the results obtained after a year's work are still far from satisfactory. Shield budding in all its modifications has given very poor results; cleft grafting has been more successful and should give 40 to 60 per cent of growing grafts. The scion should be made of well-matured growths not too old and hard, 6 to 8 centimeters long and 7 to 10 millimeters in diameter, and should be inserted in the stock 6 to 10 centimeters above the ground, when at that height the stock is 7 to 15 millimeters in diameter. After tying the graft, carefully cover all wounds with grafting wax. Like cacao the lanzone is difficult to transplant and it is best to rear the seedling plants in bamboo tubes for transplanting to the orchard and to perform the grafting operation there, not in the nursery.

Mangosteen, *Garcinia mangostana.* Like most other tropical fruits the mangosteen is propagated from seed. It is of course self-evident that the propagation of seedless varieties or the extension of the mangosteen season cannot be accomplished until the mangosteen can be propagated asexually. However, the mangosteen is of such exceedingly slow growth that it will probably never be chosen as a stock until all other possibities have been exhausted.

Generally speaking, the requirements for successful grafting or budding are about the same in related plants, and in order to ascertain the ease with which *guttiferous* plants might be shield budded a series of buds were inserted on the Palo Maria, *Calophyllum inophyllum.* These buds, about one half of which were petioled, all made good unions and sprouted without difficulty, which indicated that related plants would likely be "easy" subjects. A few plants of the guta-gamba, *Garcinia venulosa,* were on hand and these were also budded, and a dozen buds of this species (*Garcinia venulosa*) were also inserted in *Calophyllum inophyllum* stock. All the buds took and made perfect unions. Well-matured but green and smooth, nonpetioled mangosteen budwood was then procured and buds inserted both on *Garcinia venulosa* and *Calophyllum inophyllum.* Good unions resulted in most instances. Four months after the insertion of the buds nearly all the buds of *Garcinia venulosa* and 50 per cent of the mangosteen buds were still alive, but had not sprouted and are gradually being callused over.

The result of this experiment indicates that the budding of the mangosteen is easily accomplished and that the real problem is the discovery of a congenial, vigorous stock.

The mammee, *Mammea americana*, a guttiferous fruit of tropical America has very good shipping qualities and is of considerable variation, some trees bearing fruit of excellent quality. If, as is probable, this species can also be readily shield budded, there is a possibility that the mammee before long will go through the same experience as the avocado, which was all but unknown until about 15 years ago when it was found in Florida that it could be budded. Following the advent of asexual propagation, large numbers of varieties of avocado have now sprung into existence and its cultivation is rapidly spreading. Considering the short time since the culture of the avocado was placed on a scientific basis, large areas have been planted to this fruit in Florida, California, Cuba and Porto Rico.

It has recently been noted that, as with several other plants, severed roots of the carambola, *Averrhoa carambola* and bael, *Aegle marmelos*, are able to develop germinative tissue and establish themselves as independent plants.

NOTES ON SUGAR, BY CLEVE. W. HINES, M. S., Station Superintendent.

INCREASED DEMAND FOR PHILIPPINE SUGAR CAUSED BY THE WAR.

There has been an increased demand for Philippine sugar occasioned by the recent war and this demand will be felt for a long time after the war has finished. Under normal conditions it is difficult to dispose of any but the very highest grade of molasses sugars in the United States, and these are taken only to fill the gap between the crops of centrifugal sugars, or in a time of scarcity of sugars as in the present case.

The centrifugal sugar made in these Islands, however, is always in demand and is usually transported directly from the wharf of the central to the refinery, which eliminates the paying of storage and agents' profits.

NOTED SUGAR TECHNOLOGIST ACCEPTS POSITION AS MANAGER OF LARGE CUBAN SUGAR PLANTATION.

Mr. Noel Deerr, the sugar technologist who was for many years connected with the Hawaiian Sugar Planters' Association, resigned his position to take up extensive research in the sugar industry for the Cuban Government. He has since resigned that position to accept an appointment as Superintendent of the Jobato Sugar Estate in Oriental Cuba.

INSTRUCTIVE PAPER ON SUGAR DETERIORATION.

Prof. W. L. Owen read a very able paper before the Louisiana Sugar Planters' Association at their March meeting, on the subject "Some Factors Influencing Sugar Deterioration." He stated that scientific investigations had shown that sterile sugars do not deteriorate and that in order to preserve these sugars for an indefinite period of time it is only necessary to properly enclose and store them in a suitable dry place.

SUGAR CROP OF LOUISIANA.

The sugar crop of Louisiana for the year 1914 amounted to 242,700 short tons, which was nearly 50,000 tons less than the previous crop. This shortage was caused by the smaller acreage occasioned by the reduction of tariff on sugars. It is interesting to note that about one-half of the output for the past year was made in the form of a high-grade sugar for direct consumption. There were 149 factories in operation the past year as against 153 during the previous year.

MICROÖRGANISMS IN CANE JUICE.

A very interesting article from the eminent sugar technologist, Dr. H. C. Princen Geerligs, appeared in the February number of the Louisiana Planter, entitled, "Action of Micro-Organisms in Cane Juices and Syrups." He states that one of the most troublesome organisms in cane juices, once it gets started, is the *Lenconnostoc misenterioides* which gives rise to the gelatinous substance called "dextran." This organism finds more favorable condition for growth when the juice is in an alkaline state.

WORLD'S SUGAR PRODUCTION.

The world's production of sugar for the years 1912–13, 1913–14 and estimated by Willett Gray for 1914–15, is as follows:

	1914-15	1913-14	1912-13
Total cane sugar	9,588,096	9,802,248	9,232,543
Total beet sugar	7,901,759	8,850,470	8,976,271
Grand total	17,489,855	18,652,718	18,208,814

SUGAR-BEET SEED PRODUCED IN THE UNITED STATES.

On account of the European war there will probably be very little sugar-beet seed sent out of Germany and Austria for a long time to come and consequently the United States must look for a new source of supply.

A valuable article appears in the May number of "Sugar" by Dr. Frank S. Harris, agronomist, Utah Agricultural Experiment Station, who has done extensive work in this line. He states that sugar-beet seed can be readily produced in certain sections of the United States and that there are great prospects for this new industry in the West where a considerable area will be planted in the State of Utah the present year.

NOTE BY DR. W. H. BOYNTON, Veterinary Pathologist.

SINGAMUS LARYNGEUS.

In the American Journal of Veterinary Medicine for June, 1915, there appeared a note on "*Syngamus laryngeus* from Cattle in the Philippine Islands" which will be of special interest to students of parasites of domestic animals. This note was written by Dr. Maurice C. Hall, Assistant Zoölogist of the United States Bureau of Animal Industry, Washington, D. C., and is as follows:

In a collection of parasites furnished to the United States Bureau of Animal Industry through the courtesy of Dr. William H. Boynton of the Philippine Bureau of Agriculture, there were a number of specimens of *Syngamus laryngeus* Railliet, 1899, collected in the vicinity of Manila. Some of the specimens were loose in a bottle and others were attached to the laryngeal mucosa in the region at the base of the epiglottis in a larynx from a cow. They also occur in the carabao.

The species was described by Railliet from material sent him from Nha-Trang, Annam, where it was found in over half of a hundred cows examined postmortem in connection with a study of rinderpest. In this connection it may be noted that the bovine specimen furnished by Dr. Boynton also shows lesions of rinderpest. The record of this parasite given by Railliet has been quoted by a number of other writers, such as Neuveu-Lemaire, Fiebiger, and Hutyra and Marek, but I have not found any additional records.

An examination of the Philippine material shows it to be identical with that described by Railliet. The males average a little shorter, measuring 2.75 to 3.1 millimeters, where Railliet's specimens measured 3 to 3.75 millimeters, and the females with which these males are coupled are a little longer, measuring 9.7 to 12 millimeters, where Railliet's specimens measured 8.75 to 9.8 millimeters. The worm shows the transverse striation of the cuticle, and the strong buccal capsule with eight teeth at the base of eight chitinous ribs extending from the base to the mouth aperture.

A very interesting thing in connection with these worms was the finding of one pair of which the male was attached to the vulva of the female in the usual way and also attached to the neck of the female by the buccal capsule. In another case, the male of one couple was attached by means of the buccal capsule to a point opposite the vulva of a female belonging to another couple. In both of these cases the powerful suction had drawn the cuticle of the female deep into the capsule, but not quite in contact with the teeth at the base. With the cuticle, and still protected by it,

were parts of the viscera of the attacked female, including a piece of the ovary in the case of the female attacked by the male of another couple.

In the writer's experience such occurences are rare. However, I am told by Dr. Albert Hassall that the attachment of one trematode to another is not uncommon, and that Rudolphi has made one trematode species which subsequent examination of the type material has shown to be based on a specimen showing a protuberance which was evidently due to a previous attachment of another fluke. The protuberance, which formed a distinguishing character of Rudolphi's species, represented the part of the attacked fluke which had been drawn into the sucker cavity. Grassi and Parona (1879) have reported a case in which two specimens of *Dochmius balsami* (*Ancylostoma caninum*) were found attached to a specimen of *Taenia crassicollis* in a cat.

Railliet states that the worms apparently gave rise to no pathological conditions, except for the immediate local attachment, of course, and there is no record of any correlated pathological effects in connection with the infestation with this worm in the Philippines.

133070——7

ERRATA.

In Vol. VIII, No. 2, of this REVIEW, the following corrections should be made:

Page 71, line 37, "cautemoya" should read "cuatemoya;" page 111, third line from the bottom, "325 millimeters;" should read "3.25 millimeters;" same page, fifth line from bottom, "45 to 75 centimeters" should read "4.5 to 7.5 centimeters;" same page, nineteenth line from bottom, "well-known" should read "well-grown."

STATISTICS ON PRINCIPAL CROPS OF THE PHILIPPINE ISLANDS FOR THE YEAR ENDING JUNE 30, 1914.

(Compiled from the official reports submitted by the executive officers of 1 city, 743 municipalities, 84 townships, 25 rancherias, and 8 settlements.)

By ANTONIO PEÑA, *Superintendent of Statistics.*

Crops.	Area cultivated.	Products.	Amount produced.	Average price in municipal markets.	Value of coconut and sugar-cane products in municipal markets.	Total value in municipal markets.
	Hectares.					
Rice	1,244,937	Rough rice	1,705,261,050 liters	₱0.03358		₱57,261,760.19
Abaca	437,470	Abaca (Manila hemp)	137,635,558 kilos	.21773		29,968,009.23
Sugar cane	169,436	Crude sugar	346,429,556 kilos	.0752	₱26,035,568.35	
		Panochas (small cakes)	24,013,110 kilos	.0719	1,726,761.76	
		Basi (a beverage)	9,342,514 liters	.0731	682,668.51	
		Molasses	2,480,029 liters	.0752	186,546.10	
		Total value of all sugar-cane products				28,631,544.72
Coconuts (average of 200 trees per hectare).	245,952	Ripe nuts as food	63,057,700 nuts	.03997	2,520,160.66	
		Copra	107,382,931 kilos	.1618	17,385,087.79	
		Coconut oil	3,595,332 liters	.3408	1,225,412.86	
		Tuba (a beverage)	54,048,393 liters	.0651	3,521,102.72	
		Total value of all coconut products				24,651,764.03
Corn	421,309	Shelled corn	469,961,119 liters	.03378		15,873,804.27
Tobacco	60,890	Leaf tobacco	46,731,463 kilos	.1521		7,109,367.34
Maguey	18,218	Maguey (cantala)	7,583,802 kilos	.1135		860,754.41
Cacao (estimated)	1,168	Cacao	565,802 kilos	.6257		354,057.21
Coffee (estimated)	788	Coffee	626,408 kilos	.4833		302,770.60
Total	2,600,168					165,013,832.00

Equivalents.—1 hectare equals 2.471 acres. 1 kilo equals 2.20462 avoirdupois pounds. 1 liter equals 0.908077 dry quart or 1.0567 liquid quarts. ₱1 (Philippine currency) equals $0.50 (United States currency).

NOTE.—The total area of the Philippines, including all 3,141 islands, islets and reefs, has been reported by the Manila Observatory to be 119,542 square miles, which is equivalent to 309,615 square kilomters, or 30,961,500 hectares.

The area under cultivation in the six principal crops and three of the minor crops, as shown in the above table, is only 2,600,168 hectares. This is 8.4 per cent or about one-twelfth of the whole area of the Islands including mountains and arid lands.

The area under cultivation in fruit trees, bananas, camotes, ubi, gabe, and other vegetables is not included in the above table for the reason that complete statistics on these crops are not available.

RICE NUMBER

The Philippine

Agricultural Review

VOL. VIII FOURTH QUARTER, 1915 No. 4

SPECIAL ARTICLES

OBSERVATIONS ON THE INFLUENCE OF AREA PER PLANT ON YIELD OF GRAIN IN RICE CULTURE

By H. O. Jacobson

THE CAUSES OF LOW YIELDS OF RICE IN THE PHILIPPINES

By H. O. Jacobson

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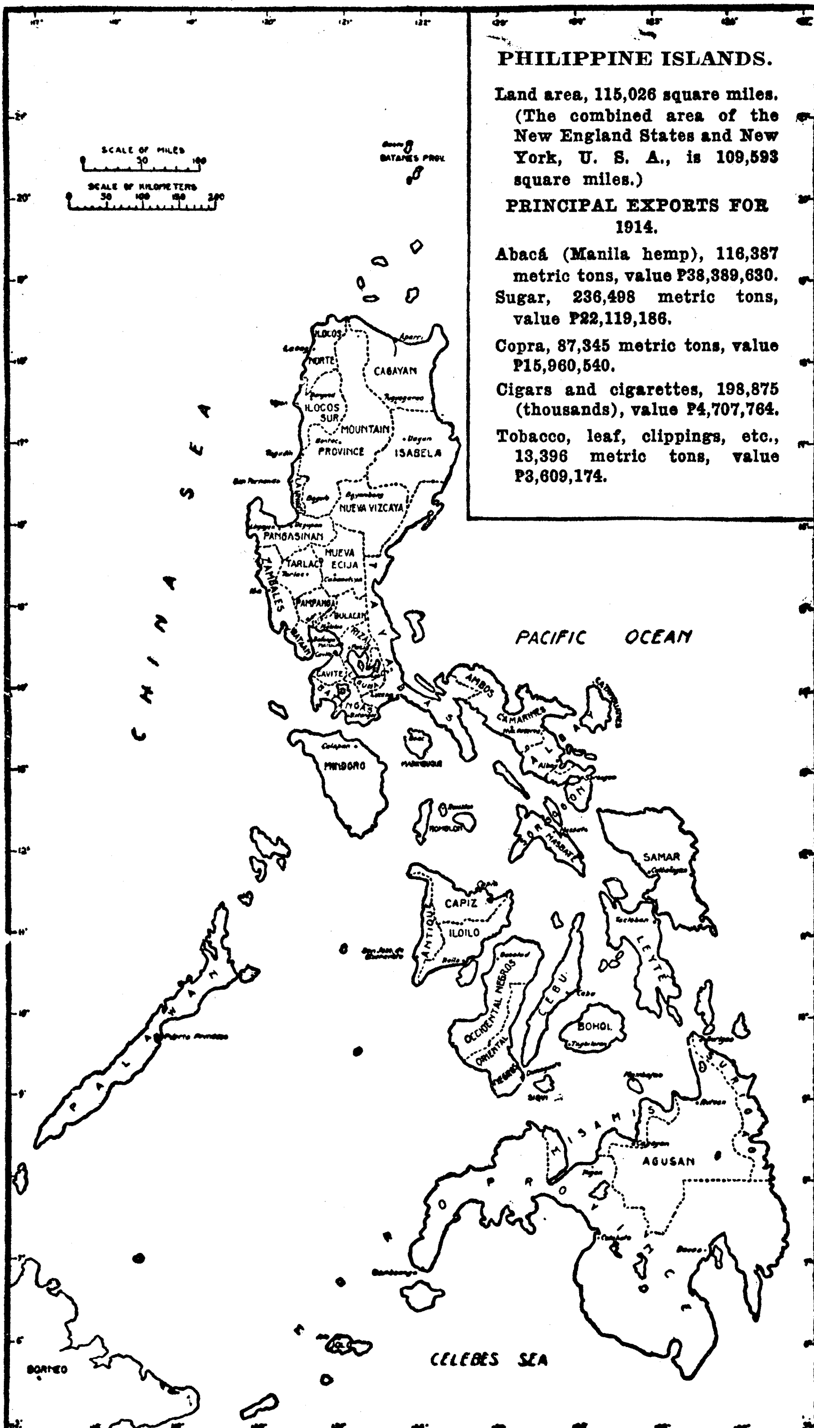
PHILIPPINE ISLANDS.
Land area, 115,026 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1914.
Abacá (Manila hemp), 116,387 metric tons, value P38,389,630.
Sugar, 236,498 metric tons, value P22,119,186.
Copra, 87,345 metric tons, value P15,960,540.
Cigars and cigarettes, 198,875 (thousands), value P4,707,764.
Tobacco, leaf, clippings, etc., 13,396 metric tons, value P3,609,174.
SCALE OF MILES
SCALE OF KILOMETERS
CHINA SEA
PACIFIC OCEAN
CELEBES SEA
BORNEO
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
CAVITE
MINDORO
ROMBLON
MASBATE
SAMAR
LEYTE
CAPIZ
ILOILO
ANTIQUE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
MISAMIS
AGUSAN
MORO PROVINCE
PALAWAN

PLATE I.

A portion of the testing fields showing the rows planted with seeds from selected mother plants. Preliminary feature of pedigree work.

RICE NUMBER

THE PHILIPPINE

Agricultural Review

VOL. VIII FOURTH QUARTER, 1915 No. 4

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THE PUBLIC AND PUBLIC SERVICE IN AGRICULTURE.

The past decade has been marked by the development of a rapidly growing interest on the part of the general public in various lines of agricultural effort. Never before has there been such a world-wide interest in this subject, or in farmers as a class, as that which prevails today.

That there should be a widespread interest in agriculture is most natural when it is considered that by far the greater part of the world's food supply comes from the farms. That this interest should increase as the cost of food increases is also inevitable.

It is highly desirable both in the interests of the farmer and of the consumer of the products of the farm that the general public should have an intelligent understanding of agricultural conditions. Where such an understanding exists there is at least a reasonable probability that the efforts made by the consumer to promote the welfare of the farmer will accomplish the desired results. Where it does not exist there is equal probability of failure.

It is a fact surprising, but none the less true, that agriculture has suffered neglect because of the familiarity of the public with this industry. The tilling of the soil was one of the first arts to be developed, and agriculture being a fundamental and world-wide industry has required the services of a larger proportion of the world's population than any other one line of human effort. As other industries have been developed they have been manned in considerable measure by people drawn from agricultural pursuits. As a result of this situation it is a rare experience to meet a man who does not feel confident that he can successfully operate any agricultural enterprise and give sound advice on the many topics bearing thereon. The same man will scrupulously refrain from advising the doctors, lawyers, clergymen, engineers, bankers, and merchants although none of these persons are engaged in professions or business which involve as many technical features as do the operations involved in the production of a staple crop.

As a matter of fact, during the last two decades agriculture has emerged from a "rule of thumb" art to a profession fairly bristling with science. It is rapidly changing from a "one-man independently-operating" business to a community enterprise. The evolution has been so radical and rapid that the public at large and many of the farmers themselves do not realize what has transpired. Consequently, we have the public on one hand sagely offering the farmers advice with but a superficial knowledge of the subject, based on the assumption that conditions have not and are not changing, and on the other hand a certain class of farmers blindly refusing to accept or acknowledge present-day conditions and attempting to treat their farms as the self-sustaining, self-sufficient, and independent enterprises they were a generation ago.

An unfortunate result of this situation has been the development of a certain amount of antagonism between country and city people. The farmers have a tendency to regard the people of the cities as parasites; whereas the city people are in a measure inclined to look upon the country people as legitimate prey. This condition where it exists is largely due to ignorance, as both classes are mutually dependent each upon the other, and their interests are, in the main, identical.

In the more progressive localities and among the more intelligent people the idea is growing that the community embraces the largest possible unit. The town embraces all the hamlets and farms naturally contiguous to it and the city embraces all of these larger communities naturally contiguous to it.

As a result of the realization of a community interest we find the people who live in cities and towns contributing to the support of different agencies designed to educate the farmer. Two of the most prominent of these agencies are the agricultural agent and the experiment station.

The public, having provided the necessary means for the employment of an agricultural agent, or having contributed to the support of an agricultural experiment station, is always disposed to constitute itself a critic of the work of such agents and stations. Such criticism, when based on an intelligent understanding of the work, may be most helpful, otherwise it may do a great deal of harm.

The agricultural investigator who is engaged in public service has to meet at all times a more or less insistent demand for specific and immediate results. In order to meet this demand, even in a moderate degree, the work of the investigator is

often seriously hampered, and his employer—the public—suffers serious loss.

That which is most urgently needed is confidence on the part of the public in the ability of agricultural specialists employed in public service to properly carry on the work in which they are engaged. The wonderful results that have already been accomplished along many lines of agricultural research have tended to establish the confidence of the public in such work, and as other and more important results are obtained, the agricultural specialist may confidently expect the stronger and more general support of his work by the public.

OBSERVATIONS ON THE INFLUENCE OF AREA PER PLANT ON YIELD OF GRAIN IN RICE CULTURE.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

An important point in lowland rice culture is the proper spacing of hills. Just how far apart may hills be spaced without prejudice to maximum yield of grain? If, on the other hand, close planting is deemed essential to prevent weed growth, how closely may the hills be set?

It has been noted that there is great diversity in practice in these Islands, in so far as spacing of hills is concerned. In some districts very close planting is customary, in others the contrary. The prevalent tendency with all crops is too close planting, and the impression the casual observer retains is that rice is commonly overcrowded in the field.

The habit of planting too closely is wasteful. In the first place, a certain amount of seed is wasted for which there is far greater utility as food. If but a small percentage of each cavan [1] of seed so used is superfluous, the sum total thereof amounts to considerable proportions.

Calculating that one cavan of seed is sufficient to plant a hectare of lowland rice and a cavan and a half to plant a hectare of upland rice, not more than a million and a half cavanes of seed will be required to plant the 1916 crop. But not less than 750,000 cavanes of rice will be planted in addition to the amount actually necessary, which at seed prices is a waste of more than two million pesos, in the first instance, not to mention other wastes that naturally follow the initial one. Among other wastes is that of labor in setting out more hills of plants to the hectare than are necessary. If such close planting interferes with the normal growth of the plants, still another waste occurs, and there are other relative wastes.

[1] One cavan equals 75 liters.

A preliminary investigation was conducted at the Alabang stock farm with the object in view of determining the influence on yield due to differences in spacing of hills.

Three quite widely differing varieties were selected to be planted in this test. One was an early-maturing variety, No. 663, requiring about 145 to 148 days to ripen; a medium-early one, No. 692, maturing in 174 days; and a late-maturing sort, No. 225, ripening in 187 days.

The seed was sown June 15 in seed beds and the seedlings transplanted six weeks later in a set of five duplicate plots, each plot being ten meters in length and of sufficient width to accomodate six rows of plants.

Only one seedling was set in the hill, and in order to equalize the distribution of plant food in the soil, border rows were set on the sides of the plots so that each set was a solid block.

The following table shows the general scheme of handling the plots.

Series No.	Spacing.	Plants per square meter.
	Centimeters.	
I	10×10	100
II	10×15	67
III	15×20	33
IV	20×20	25
V	25×25	16

During the early period of growth there was no noticeable difference in the general appearance of the several plots in the series, but by the time the plants began to bloom, they were taller, more slender, and somewhat paler in color in series I and II than in the others. The differences in average height of plants between series I and II at heading-out time was 2 centimeters and between series II and III the same. Series IV and V were uniformly similar to series III.

By the time the kernels were in the dough state there was no difference in the heights of the plants of a given variety in the several plots. All plots matured at the same time, so there was no influence on maturing period due to close or sparse spacing of hills.

The following table shows the results obtained:

EXPERIMENT No. 1.

Spacing.	Variety No.	Average— Number of culms per plant.	Height of plants.	Length of panicle.	Number of branches per panicle.	Number of grains per panicle.	Yield of rough rice per square meter.	Yield of straw per square meter.	Number of bearing culms per square meter.	Yield of rough rice per 1,000 culms.
Centimeters.			*Cm.*	*Cm.*			*Kilo.*	*Kilos.*		*Kilos.*
10 × 10	663	3.0	126	24.0	9.5	113	0.439	0.323	300	1.46
	692	2.4	136	22.3	9.8	127	.354	1.26	240	1.47
	225	3.5	157	31.0	9.5	117	.317	1.24	350	.905
10 × 15	663	3.6	128	25.3	10.0	135	.388	.280	239	1.62
	692	3.7	136	22.9	10.6	151	.299	1.11	246	1.22
	225	4.0	158	32.0	10.8	147	.241	1.17	266	.906
15 × 20	663	4.7	129	25.3	9.7	135	.282	.333	157	1.79
	692	4.5	138	22.6	10.5	161	.233	.759	150	1.55
	225	4.4	154	32.3	11.4	155	.187	.910	147	1.27
20 × 20	663	5.2	129	25.3	9.4	139	.197	.347	130	1.52
	692	6.2	139	22.7	10.3	172	.231	.862	154	1.50
	225	5.4	156	31.7	11.4	145	.158	.873	135	1.17
25 × 25	663	6.3	127	25.1	9.5	137	.188	.383	101	1.86
	692	5.7	138	23.0	10.6	154	.172	.427	91	1.89
	225	5.7	151	31.9	12.4	168	.148	.689	91	1.62

As the area per plant was enlarged the number of culms per plant increased, though less marked in the tallest and latest-maturing variety.

The variation in space per plant apparently had little effect on the height. The length of the panicle was not affected.

The number of branches per panicle remained stable in both the earlier varieties but gradually increased in number on the late-maturing one as the area per plant was enlarged.

With all varieties the number of grains per panicle was less when only 100 square centimeters was allotted each plant, but when the area was increased to 150 square centimeters or more per plant the average number was but little affected. The other variations recorded with regard to number of grains are deemed to be too slight to be considered.

The yield of grain dropped according to the space allowed plants, indicating that not more than 100 square centimeters per plant should be allowed in order to secure maximum yields, but that a lesser area would suffice. It is regretable that the series were not planned to include closer spacing.

An explanation for the high yield on the closely planted plots is found in the greater number of bearing culms per square meter. This condition offsets any increase due to a greater number of culms per plant, and a greater number of grains per panicle. None of the varieties was capable of stooling sufficiently to provide as many culms as the soil could support.

The yield of straw was but slightly influenced by difference in spacing in the earliest-maturing variety, but it fell off rapidly with the other two as the area per plant was enlarged.

Another preliminary test was made with reference to the effect of various numbers of seedlings per hill, using the same varieties as in the test discussed above.

In this investigation all hills were spaced 25 centimeters apart both ways, and one, two, three and four seedlings placed in each hill. Unfortunately, all but one set were washed away by a flood of water. This was variety No. 663.

The results of this test are recorded as follows:

Number of plants per hill.	Average—				
	Number of culms per hill at harvest.	Height of plants.	Length of panicle.	Number of grains per panicle.	Yield per square meter.
		Cm.	*Cm.*		*Kilo.*
1	8.9	144	26.1	141	0.271
2	9.3	143	25.9	142	.250
3	9.6	140	24.6	139	.286
4	9.8	138	24.8	124	.263

Reference to the tabulation of "Experiment No. 1" shows that No. 663 did not tiller as fully in that test as in the one shown just above, the rate being 6.3 culms to the plant as compared with 8.9. It is not possible to account for this difference by referring to the data on hand. The seedlings for all the plots planted with No. 663, in all the work considered so far, were taken from the same seedbed and planted on the same date. The soil was very uniform in all respects. The average maintained by this variety in plot tests is 6.2 culms per plant, consequently the results obtained with reference to yield were evidently affected by other influences than those under consideration.

Since the preliminary test with reference to the effects of space per plant on yield had led to such positive results, a much more extensive experiment was planned for the succeeding season.

The same varieties were used and the seedbeds sown June 26, the plots planted July 23 to 26, inclusive.

Five sets of duplicate plots were laid out to be planted with 1, 2, 3 and 4 seedlings per hill, and the hills to be spaced 10 by 10 centimeters; 10 by 15 centimeters; 15 by 15 centimeters; 15 by 20 centimeters and 20 by 20 centimeters. This arrangement provided for 100, 150, 225, 300 and 400 square centimeters per hill and with the planting of 1, 2, 3 and 4 seedlings per hill, the subdivision of each area was made accordingly.

In order to make comparisons with the first season's results, the plots with single seedlings will be treated first.

EXPERIMENT NO. 2—*One seedling to the hill.*

Spacing.	Variety No.	Average—				
		Number of culms per plant.	Number of grains per panicle.	Yield of rough rice per square meter.	Number of bearing culms per square meter.	Yield of rough rice per 1,000 culms.
Centimeters.				*Kilo.*		*Kilos.*
10 × 10	663	3.4	98	0.185	340	0.544
	692	2.4	137	.129	240	.537
	225	2.7	160	.163	270	.603
10 × 15	663	3.8	100	.159	253	.628
	692	2.8	147	.140	186	.753
	225	3.2	175	.185	213	.869
15 × 15	663	4.9	114	.148	217	.682
	692	2.5	155	.156	111	1.40
	225	3.1	167	.113	138	.819
15 × 20	663	5.4	98	.161	171	.941
	692	4.2	110	.119	140	.850
	225	3.3	146	.177	110	1.61
20 × 20	663	5.7	132	.161	142	1.13
	692	4.1	144	.141	102	1.38
	225	4.2	157	.125	105	1.19

EXPERIMENT NO. 3—*One seedling to the hill.*

Spacing.	Variety No.	Average—				
		Number of culms per plant.	Number of grains per panicle.	Yield of rough rice per square meter.	Number of bearing culms per square meter.	Yield of rough rice per 1,000 culms.
Centimeters.				*Kilo.*		*Kilos.*
10 × 10	791	4.8	----------	0.333	480	0.695
	97	4.2	118	.417	420	.993
	426	6.4	113	----------	640	----------
10 × 15	791	6.4	----------	.329	426	.772
	97	5.2	120	.403	346	1.16
	426	8.2	151	----------	546	----------
15 × 15	791	12.6	----------	.277	559	.495
	97	6.2	117	.303	275	1.10
	426	9.6	178	----------	426	----------
15 × 20	791	11.2	----------	.280	373	.751
	97	6.8	142	.264	226	1.17
	426	10.6	158	----------	353	----------
20 × 20	791	11.2	----------	.244	280	.871
	97	6.8	----------	.214	170	1.43
	426	7.8	195	----------	195	----------

Variety No. 692 does not attain its average tillering rate which is 6.5 in the variety plot test records, neither does No. 225 which has an average tillering record of 6.0 in the variety plot tests. Sometime ago the writer adopted the unit of .34 square centi-

meters per culm as a useful standard for population basis, and it will be noted that where the number of culms closely approaches this proportion, or about 330 culms to the square meter, is also found the maximum yield.

When the number of culms falls below this figure, even if more grains are found on the panicle and though the number of culms in the stool is larger, the yield tends to fall off as the square area per plant increases.

The tillering habit is rather elastic although it is quite apparent that the maximum limit is well defined and additional space per plant does not induce tillering beyond a certain definite point.

The number of kernels per panicle is usually regarded as a stable character but as a matter of fact this habit is affected by environment and the degree of stooling which has occured. The average number of grains per panicle of variety No. 665, according to records, is 142, which average number is closely approached except in the closest planting.

The data submitted for Experiment No. 2 are not regular, and there are indications that other influences than those of spacing are in part responsible for the variations from the expected results. This assumption is supported by the fact that the effects of insect attacks and short water supply had to be considered in part. However, the progression of figures is such that one can make deductions. An unknown factor is the weight per 1,000 grains, which if known would explain certain discrepancies.

In Experiment No. 3, several figures are omitted because of doubtful value. The data remaining exhibit a similar manner of progression as noted in the preceding table. One exception should be noted. The number of culms per square meter is unsually large, which fact was accredited to the very favorable growth conditions prevailing during the early part of the season, shortly after transplanting.

Altogether, the most logical deduction which can be drawn from the preceding data is that single seedlings will usually not produce maximum yields if given more space than 100 square centimeters, and that the maximum limit to number of grains per panicle, tillering habit, or possible increase of grain size, is definite and fixed so that, beyond certain restricted limits, these characteristics are not sufficiently elastic to be relied upon to compensate fully for sparseness of plant population per square meter.

In order to get further information the same scheme of spacing as used in Experiments Nos. 2 and 3 was employed, and two and four seedlings were placed in each hill.

EXPERIMENT No. 4.—*Two seedlings to the hill.*

Spacing.	Variety No.	Average— Number of culms per hill.	Average— Number of grains per panicle.	Average— Yield of rough rice per square meter.	Average— Number of bearing culms per square meter.
Centimeters.				*Kilo.*	
10 × 10	663	3.5	82	0.161	350
	692	2.3	117	.111	230
	225	2.8	142	.161	280
10 × 15	663	3.8	73	.201	253
	692	2.6	187	.153	173
	225	3.5	156	.163	233
15 × 15	663	4.4	118	.181	195
	692	4.1	121	.125	182
	225	3.3	149	.129	146
15 × 20	663	5.6	113	.184	186
	692	3.4	126	.133	113
	225	3.8	141	.185	126
20 × 20	663	5.7	138	.177	142
	692	4.4	179	.171	110
	225	4.4	142	.109	110

EXPERIMENT No. 5.—*Two seedlings to the hill.*

Spacing.	Variety No.	Average— Number of culms per hill.	Average— Number of grains per panicle.	Average— Yield of rough rice per square meter.	Average— Number of bearing culms per square meter.
Centimeters.				*Kilo.*	
10 × 10	791	6.6	----------	0.256	660
	97	4.0	129	.383	400
	426	5.0	150	----------	500
10 × 15	791	9.4	----------	.463	626
	97	4.2	135	.381	280
	426	4.8	200	----------	320
15 × 15	791	10.3	----------	.333	577
	97	6.0	134	.429	266
	426	5.4	154	----------	240
15 × 20	791	13.0	----------	.103	433
	97	7.8	131	.281	260
	426	11.0	160	----------	366
20 × 20	791	13.6	----------	.262	340
	97	10.2	106	.210	255
	426	11.4	166	----------	285

EXPERIMENT No. 6.—*Four seedlings to the hill.*

Spacing.	Variety No.	Average. Number of culms per hill.	Number of grains per panicle.	Yield of rough rice per square meter.	Number of bearing culms per square meter.
Centimeters.				*Kilo.*	
10 × 10	663	4.2	76	0.204	420
	692	3.6	118	.129	360
	225	3.1	134	.168	310
10 × 15	663	4.3	93	.197	286
	692	4.3	135	.172	286
	225	3.8	133	.181	253
15 × 15	663	5.5	74	.189	244
	692	3.9	101	.116	173
	225	3.2	135	.141	142
15 × 20	663	5.4	110	.183	180
	692	4.2	149	.127	140
	225	3.8	137	.120	126
20 × 20	663	6.7	105	.198	167
	692	5.3	183	.166	132
	225	5.4	188	.131	135

EXPERIMENT No. 7.—*Four seedlings to the hill.*

Spacing.	Variety No.	Average. Number of culms per hill.	Number of grains per panicle.	Yield of rough rice per square meter.	Number of bearing culms per square meter.
Centimeters.				*Kilo.*	
10 × 10	791	7.4	----------	0.317	740
	97	4.4	125	.430	440
	426	2.8	148	----------	280
10 × 15	791	9.4	----------	.362	726
	97	6.0	124	.416	400
	426	3.8	144	----------	253
15 × 15	791	16.8	----------	.480	746
	97	6.0	130	.362	266
	426	7.4	149	----------	328
15 × 20	791	16.8	----------	.315	559
	97	11.0	141	.273	366
	426	12.4	144	----------	413
20 × 20	791	18.4	----------	.245	460
	97	7.0	134	.214	175
	426	10.0	140	----------	250

The introduction of more than one seedling in the hill tends to produce less regularity in the results. This is especially true with regard to the stooling of the plants, since there will be considerable variation due to the competition between the seedlings in each hill. If a hill has four equally vigorous seedlings it is to be expected that there will be a maximum number of culms per hill while if there is a great difference in the vitality of the seedlings, the weaker ones will compete at a disadvantage and will produce but few culms.

Experiments Nos. 4 to 7, inclusive, tend to show that when the loss due to death of a certain percentage of seedlings, which always operates against maximum production when only one seedling is used, is offset by planting more than one seedling in the hill, the limit to close spacing is reached in spacing hills 10 by 10 centimeters, and overcrowding results. Consequently, the greatest yields are found in the somewhat less densely planted areas. In Experiment No. 6, No. 663 shows but slight influence due to spacing but the other varieties appear to be more vitally affected.

From a practical standpoint, the gain accruing from the practice of setting out single seedlings in the hill would have to be considerable to offset the extra expense incurred in planting the field according to such a scheme. Nor is it possible to attempt to plant an exact number of seedlings in the hill. In practice it will be found that, if three seedlings to the hills is the average sought, the range will be from one or two to five or six.

Too close planting hinders economical and efficient weeding work, and may result in damage being done to the growing plants. A distance of 20 centimeters between hills appears to be quite small enough to permit the passage of the average laborer doing the weeding and yet provide for the safety of the rice plants.

Taking a general average of the results obtained does not reveal any striking feature.

Thus, one plant per hill, spaced 10 by 10 centimeters, 10 by 15 centimeters, 15 by 15 centimeters, 15 by 20 centimeters, and 20 by 20 centimeters, produced an average return of 0.151 kilo per square meter; two plants per hill, 0.154 kilo; three plants per hill, 0.159 kilo; and four plants per hill 0.161 kilo. The variation in yield per hectare is too slight to be given much attention, since an increase of 100 kilos per hectare of rough rice may easily be occasioned by any one of several other influences or by experimental error.

The number of bearing culms per square meter is usually regarded as a reliable indicator of yield yet a study of some of the data on file reveals that 12 plots averaging less than 200 culms per square meter yielded 0.154 kilo per square meter, 200 to 300 culms per square meter yielded 0.156 kilo, and 300 to 400 culms per square meter yielded 0.155 kilo. It will also be noted in Experiments 5 and 7, that the yield was not higher when the unusually large numbers of culms to the square meter were found than in instances where a much lesser number was produced.

It has been observed that a higher death rate of seedlings prevails in the close plantings than occurs in the more widely spaced ones.

The maturing period of the rice plant is not affected by the variation in spacing of hills. A variety closely planted matures in the same period of time as it does when the hills are widely spaced.

It is commonly believed that the early-maturing varieties may be more closely planted than the late-maturing sorts, and to a certain extent the results shown in the foregoing tables indicate the correctness of that opinion.

Under very intensive culture it appears that the proper spacing distance would have to be determined for each variety individually, also the approximate number of seedlings to be set in each hill. The tillering habits of varieties vary greatly and a distance satisfactory for a prolific sort would be altogether too great for one that stooled little.

In conclusion, one seedling per hill, provided with 100 square centimeters of area, evidently had all the room needed and was not able to fully utilize a greater area.

Two seedlings on 100 square centimeters evidently competed for plant food to the detriment of each other but when given 150 square centimeters of area there is no evidence of damaging competition.

If four seedlings are set in an area of 20 by 20 centimeters each seedling has 100 square centimeters of area to draw upon and the death of one seedling will make little difference apparently. It must be remembered that the full extension of the tillering habit depends on environment and, if the available food supply is abundant, the plants will quickly adapt themselves thereto by means of additional culms, so as to utilize it.

It therefore appears that with varieties maturing within $5\frac{1}{2}$ months, planting 3 to 5 seedlings to the hill and spacing the hills 20 centimeters apart in both directions will provide all the plants necessary to utilize the plant food available and yet not cause over-crowding. Furthermore such a scheme is practicable.

A hectare contains 10,000 square meters, and if hills are spaced 20 by 20 centimeters it will contain 250,000 hills, and, with an average of 4 plants per hill, one million seedlings. A cavan of rough rice, with grains of medium size, will contain about two million grains. It will therefore be seen that one cavan of seed is ample to provide seedlings to plant one hectare of land.

THE CAUSES OF LOW YIELDS OF RICE IN THE PHILIPPINES.

By H. O. Jacobson, *Chief, Plant Industry Division.*

The principal rice district of the Philippine Islands lies between Manila Bay and the Lingayen Gulf, embracing the five provinces of Bulacan, Pampanga, Tarlac, Nueva Ecija and Pangasinan, in which the area devoted to rice culture in 1914, according to statistics compiled by the Bureau of Agriculture, amounted to 432,141 hectares. This is slightly more than one third of the entire rice area in these Islands, which is 1,244,937 hectares.

The yield of rough rice in 1914 was estimated to be 22,736,814 cavanes of 43 kilos each, to which the five above-mentioned provinces contributed 8,987,729 cavanes, or 40 per cent.

In 1913, the area planted with rice in these five provinces amounted to 408,725 hectares, the total area for the Archipelago being 1,141,242 hectares and the yield of rough rice 13,147,495 cavanes, or about 53 per cent of the total production of the island group, which was 24,498,858 cavanes.

There were three other provinces in which the rice area exceeded forty thousand hectares during 1914, namely, Ambos Camarines, Capiz and Ilocos Norte. Big figures are impressive and often misleading, and in this case, the fact that even in 1913 the yield per hectare was not, by any means, as large as it should or could be, is not revealed until a more particular study is made of that feature.

It has become a very common experience to have pointed out to us the fact that our per-hectare yields are inferior to those of practically any rice-producing country whch has so far submitted statistics bearing on that industry.

In searching for the cause to which the low average yields may be attributed, the most prominent and striking and perhaps unusual feature of the rice industry here is that all but a very small proportion of the area of cultivated land devoted to rice culture

An example of excessively close planting; an average of 18 plants for each 400 square centimeters.

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The result of planting an excessive number of seedlings in the hill.

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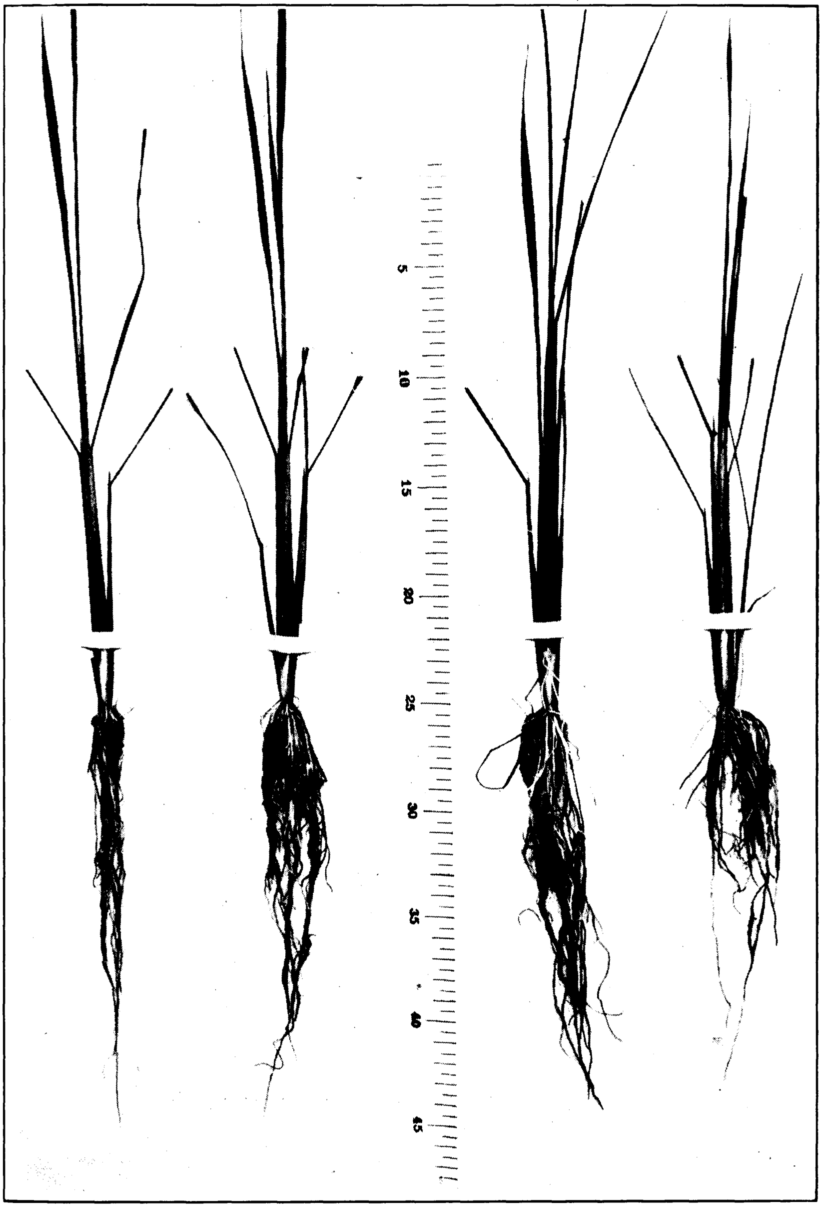

Types of seedlings; seed from same panicle; grown in same nursery bed. Note differences in structure.

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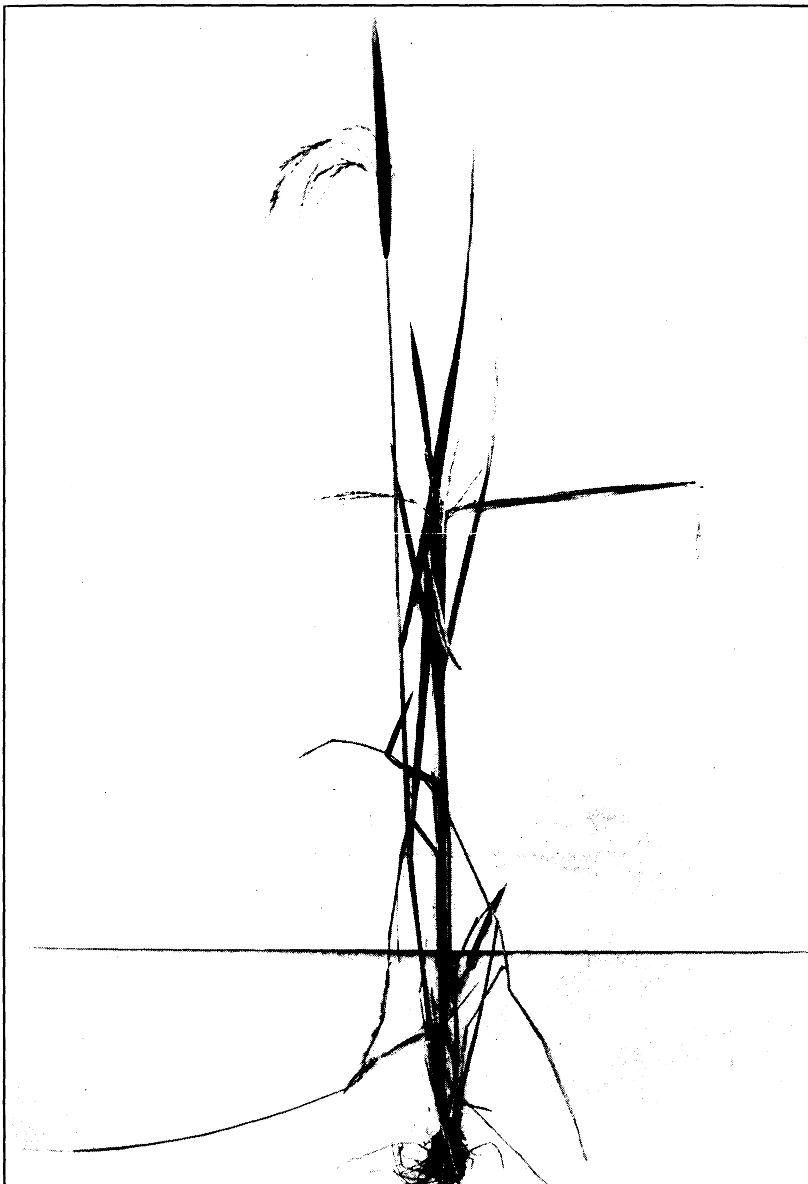

Some mother plants produce many plants like the above. One of the causes of low yields.

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is not under irrigation, even though as much as four-fifths of it is planted with lowland rice which requires an abundance of water for complete development.

In view of this fact the question arises as to whether the varieties of rice now cultivated are of such habits that they will fully develop and mature normal crops of grain with the usual supply of water which falls during the average rainy season.

For Tarlac, one of the representative provinces, we have the rainfall records for a period of twelve years, compiled by the Weather Bureau, also a record of the number of rainy days. In the first column is given the amount of rainfall in centimeters and in the second column, the number of rainy days in each month.

It will be noted that the actual rainy season is of shorter duration than is commonly believed, and, as well, much less regular. (See page 264.)

In this country, it is an axiom of the rice farmer that the rainfall must average a centimeter per day to make rice-growing conditions favorable.

According to the mean figures submitted for Tarlac, only July, August and September responded with a full quota of rainfall, with June and October of more doubtful value.

The second set of mean figures at the bottom of the table are those for Nueva Ecija. The bottom row of mean figures are for Pangasinan, the province having the greatest rice hectarage, and there we note June to September, inclusive, as satisfactory, but May and October as doubtful.

As yet no complete census has been taken of the varieties of rice grown in any of the several provinces, but one report compiled several years ago credits Bulacan Province with 117 varieties, Nueva Ecija with 235, Pampanga with 110, Pangasinan with 349, and Tarlac with 275. One province is credited with 525 varieties.

Obviously, it is quite improbable that as small a district as a province should have such varied soils and climatic conditions or divers demands to meet in the market that there should exist a necessity for such a large number of widely differing varieties.

Since the rainfall data for the Province of Tarlac have already been submitted in detail, we shall consider the varieties of rice grown there. As stated before, the 275 varieties reported may not constitute a complete list, but they are adequate for calculating reasonably accurate percentages. These are nearly all lowland sorts. The earliest-maturing variety requires 136 days from sowing in the nursery seedbed to attainment of complete maturity, the latest maturing, 219 days.

Record of rainfall and number of rainy days in the Province of Tarlac from 1902 to 1913, inclusive.

Year.	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.		Total.	
	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.
	Cm.		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*		*Cm.*	
1902	------	------	------	------	0.08	1	0.83	4	13.87	16	24.67	14	37.59	21	30.02	25	37.38	23	14.16	10	5.56	5	1.7	2	------	------
1903	0.94	4	2.44	1	0.00	0	4.67	4	8.13	6	14.63	9	42.87	26	15.57	17	22.07	20	17.17	16	9.17	7	15.09	9	152.75	119
1904	0.08	2	0.28	1	5.59	1	2.34	2	9.14	11	49.51	18	40.92	22	21.90	21	38.40	24	14.45	12	3.00	11	0.20	4	185.81	129
1905	0.05	1	0.00	0	3.10	4	16.16	7	3.94	6	28.98	18	53.81	22	24.91	20	41.96	22	21.36	19	2.19	2	0.06	2	196.52	123
1906	0.61	3	0.48	3	4.57	5	6.38	6	47.86	14	14.15	18	22.36	21	36.98	21	49.01	25	36.53	15	13.61	13	0.79	4	233.33	148
1907	0.03	1	0.00	0	0.69	1	1.66	6	15.82	15	16.92	19	35.27	23	74.86	29	35.74	22	20.23	15	1.35	13	2.54	5	205.11	149
1908	0.58	4	1.08	3	0.30	1	5.05	3	34.65	21	26.27	15	48.65	23	51.73	26	30.64	18	30.54	19	28.85	9	8.16	4	266.50	146
1909	1.57	3	1.30	4	0.64	2	5.78	8	24.33	20	7.81	14	34.84	24	23.55	18	32.93	12	32.78	16	16.84	10	13.40	5	195.77	136
1910	0.08	1	0.10	1	7.88	7	8.36	6	32.99	15	10.79	11	21.36	18	25.63	22	36.13	21	7.33	10	8.11	13	1.12	3	159.88	128
1911	------	------	3.02	3	1.50	4	11.61	9	5.45	13	11.18	12	92.49	25	21.52	22	28.25	16	4.63	4	0.36	1	2.94	3	182.95	------
1912	2.38	3	1.85	1	.97	1	4.90	3	11.43	9	36.41	20	42.96	22	44.82	27	31.55	21	19.02	16	7.97	13	0.87	1	205.13	137
1913	1.14	3	0.00	0	.97	1	11.22	5	15.23	11	27.66	16	29.47	25	35.80	24	36.64	22	11.43	12	0.99	3	4.14	3	174.69	125
Mean	0.75	2.5	0.96	1.5	2.19	2.3	6.58	5.2	18.57	13.1	22.42	15.3	41.88	22.7	33.94	22.7	35.06	20.5	19.14	13.7	8.17	8.3	4.25	3.8	193.91	131.6
THE DATA GATHERED AT TWO SEPARATE AND DISTANT POINTS IN THIS DISTRICT ARE APPENDED FOR COMPARISON.																										
1902 to 1907	1.02	1	0.67	1	0.80	.4	2.16	1.6	13.12	6.6	24.09	10.2	37.35	13.6	21.28	10.6	30.70	12.2	22.30	8.2	5.95	2.6	3.80	2.6	163.84	70.6
1902 to 1913	1.07	3.1	1.90	2.2	3.02	3.3	7.28	6.4	28.36	13.5	31.76	17.6	57.01	22.3	44.29	23.6	46.51	20.9	19.88	12.5	6.16	5.9	1.50	3.2	248.74	134.5

Classifying the varieties according to required periods to mature we find the distribution as follows:

Days to maturity.	Per cent.
150 or less	11.6
151 to 165	14.0
166 to 180	39.5
181 to 195	16.3
196 or more	18.6

Therefore, 74.4 per cent of the varieties now in culture require $5\frac{1}{2}$ or more months to produce the crop.

In order to fully appreciate the influence of maturing period on probable yield of grain, the records of 43 Tarlac varieties in plot tests, under irrigation, will be of interest. According to maturing periods the average production of rough rice per hectare is as follows:

Days to maturity.	Kilos.
150 or less	2,061
151 to 165	2,011
166 to 180	1,991
181 to 195	1,891
196 or more	1,358

It appears that with an abundant supply of water for irrigation purposes average normal yields will be obtained quite irrespective of the maturing period if it is found within rather wide limits. It also appears that even with the best of facilities for irrigation, there is nothing to be gained by growing the varieties which require more than six months to mature; on the contrary it is quite certain that the unusual season will so seriously affect the yield that the average for a ten-year period will be materially lower than with an earlier variety. Yet in this rice district under consideration 35 per cent of the varieties in culture are so late maturing that even under adequate irrigation, normal production of grain is bound to be hampered by sundry unfavorable conditions, and *but a small part of the district is as yet under irrigation.*

The rice farmer who has no irrigation water to draw upon cannot begin his field operations as early as he should.

Before he can sow his nursery seedbed he must have sufficient rain to soak the soil so that it may be properly puddled. After five months of bright, hot sunshine and without any heavy rains, a large amount of water is required to soak the soil so that it can be tilled. It thus happens, as a rule, that during a period

of 30 to 60 days of good rice-growing weather, the farmer is busy preparing the land for planting. And this is also the time in which the crop would make its best growth if already planted.

The question arises if it is good practice to plant the rice so early that it will be set out in the field when the regular rains begin. During the past six years we have begun sowing the nursery seedbeds at our experiment station in the middle of June, and nothing has yet occurred which would give us any reason for changing that practice.

Referring to the rainfall table we find, of the twelve years, only four in which without irrigation it was possible to begin plowing in May, namely, 1906, 1908, 1909, and 1910, but in three of these years the following month was so dry that operations probably could not be continued; this would cause replowing to be necessary in July before planting could be done.

In six years out of the twelve there was sufficient rainfall to permit the preparing of seedbeds and plowing in the fields in June, namely, 1902, 1904, 1905, 1908, 1912, and 1913. If the heavy rainfall in May of 1906 had been carefully husbanded perhaps that season might have been included.

Sufficient rainfall for all sorts of cultural work with rice prevailed in July of all twelve years, unless exception is taken to 1906 and 1910 when it was rather scant. For August, only 1903 was deficient in rainfall for rice which had been planted several weeks. September is notable for good rice-growing weather throughout.

In October, six years out of twelve the rainfall was inadequate for continuous normal growth of the rice crop. Varieties which had not passed the blooming stage during the early part of the month were undoubtedly considerably damaged.

November is usually a dry month, that is to say, the rains are expected to be infrequent and of small volume. However, one season, 1908, proved to be a rare exception.

Summarizing, we find that May must be disregarded as a month in which any cultural work with rice can be initiated. Granted that the seedbeds are sown in the middle of June, the seedlings will be ready for transplanting in the middle of July, and if five-month varieties are planted, three months of good growing weather is necessary to bring the crop safely through the blooming period, which will be about October 15. Ordinarily the October weather will permit this and in about five years in ten a 165-day crop will reach normal development provided it is planted as early as July 15. However, 74.4 per

cent of the varieties require a longer growing period and consequently suffer more or less nearly every season due to lack of sufficient moisture.

In 1914, the rainfall was irregularly distributed and inadequate, consequently the yield per hectare in Tarlac Province was 15 per cent lower than in 1913; in Pangasinan it was 40 per cent lower; in Pampanga 21 per cent; in Nueva Ecija 63 per cent, and in Bulacan 22 per cent. (The rainfall table is for the calendar year, and the crop statistics for the year ending June 30.)

In other words, with as favorable weather conditions as for 1913, or with earlier-maturing varieties, a normal yield would have been secured but, since the weather conditions were not suitable for a large portion of the rice district a loss in yield of more than six and one-half million cavanes was sustained, which would have had a money value in the provincial markets of more than sixteen millions of pesos. Last year, 1914–1915, in repeated instances, small fields of early-maturing varieties planted when the remainder of the crop was set out, produced normal crops, while hundreds of hectares were not even harvested because the grain failed to fill out.

It would appear that repeated disappointing experiences with these later-maturing varieties would result in their being eventually eliminated, but with the variation in annual rainfall it occasionally happens that a satisfactory yield is secured with these and the farmer hopes that the ensuing season will be as favorable.

There seems to be a prevalent belief that early maturity is synonymous with small yields, but such is not the case, except in the extreme instances. It is true that by certain practices a given variety can be forced to mature much earlier than it normally tends to mature, but this invariably results in lessened production.

On the other hand, it is also true that a goodly number of the late-maturing varieties are very productive, always provided conditions are such that they may develop normally.

Some of these last-mentioned sorts have been in cultivation for a long time, and have been mentioned by travelers as being seen in this country. In certain sections they are considered the proper ones to grow, and it is presumed that it is in these localities that the reputations of several of the better-known varieties have been built up.

One of the best-known variety names is Macan, yet there are

many distinct sorts bearing this name, and probably not a few other names are also applied to the true Macan variety.

Misapplication of variety names leads to much confusion not only with rice, but with other crops, bananas, for example.

A practice which has lead to many erroneous beliefs is the primitive method of estimating areas by the cavan. In ordinary usage a cavan of rice land is the area which a cavan (75 liters) of seed will plant; the Bureau of Internal Revenue regards a cavan hectare as of 10,062 square meters. When, for one thing, the great difference in number of grains to the liter of different varieties is considered, it is easily realized that with one cavan of small-sized grains a much larger area may be planted.than with a cavan of large-sized grains. With transplanted rice an enormous difference in yield may result from the variation in spacing of hills and the number of seedlings set in each hill.

The relative merits of varieties are largely determined by the return harvested from the area planted with one cavan of seed, as fifty fold, one hundred fold, etc.

There are other factors which tend to prevent the rapid general adoption of earlier-maturing varieties, one of them being the insect *Leptocorisa acuta.* This pest, a common one, is nearly always present and causes a certain amount of loss. If, in a given district, the bulk of the crop is late maturing and a small part is early maturing, the insects congregate on the earliest-maturing rice and because of the restricted area they feed upon, the damage is very noticeable, sometimes amounting to a total loss of the crop. When the remainder of the crop begins to mature, the wide range for feeding then available to these insects renders the damage inflicted less perceptible, and the belief grows that it is a fault of the rice variety itself that brings the insect to it in such large numbers. Nevertheless the very late-maturing rice suffers equally as much damage as the very early for the same reason—restricted area.

The more progressive farmers realize that by planting large areas *enbloc* of the earlier-maturing varieties the damage done by the insect, if present, will not be so noticeable, but it requires a considerable amount of discernment and organization to effect this material change.

An objection quite frequently offered to earlier-maturing rice varieties is that they may mature during rainy weather and for that reason be difficult to harvest and that it may be more difficult to save the grain from damage by heating. There is

some reason for this objection and if irrigated lands were the rule instead of the exception, the most practical scheme would be to plant a variety which would ripen at the usual terminating date of the rainy season. Under prevailing conditions, however, it is a far more comfortable situation for the farmer to have a reasonably good crop each year even though it is necessary to harvest occasional ones under difficulties. It is a much simpler proposition to be forced to use extreme measures to save every alternate season's crop than to have but little or nothing to garner under more favorable conditions.

The failure of farmers generally to plant varieties of rice fully adapted to average rainfall conditions is the greatest contributing factor to the average low yields.

Next in importance is the continuation in culture of varieties, either early or late maturing, which have not sufficient productive power to yield large crop returns even under favorable conditions.

As has been previously stated (see Bulletin No. 22 of this Bureau, Rice Culture in the Philippines, p. 32), large percentages of varieties do not produce profitable yields.

According to the several classifications, varieties are divided with reference to average yields as follows:

	Less than 1,000 kilos per hectare.	More than 1,000, less than 2,000 kilos per hectare.	More than 2,000 kilos per hectare.
	Per cent.		
Non-bearded, non-glutinous, white, lowland	20.6	36.2	43.1
Bearded, non-glutinous, white, lowland	4.0	53.6	42.3
Non-bearded, non-glutinous, colored, lowland	12.7	40.4	46.8

Attention is called to the fact that the preceding figures are for plot tests under adequate irrigation and for that reason will show considerably higher rates of yield than would be the average under field conditions, where the water supply is entirely dependent on the amount of rainfall and its regularity.

An average yield of less than 2,000 kilos per hectare does not provide for sufficient profit to the farmer, so that he can maintain his industry in competition with the sugar planter or abaca grower.

Under ordinary conditions, only varieties that yield more than 2,000 kilos per hectare can be safely regarded as truly profitable.

Referring to the table previously given, we find the mean

percentage of varieties that exceed 2,000 kilos per hectare to be 43.38.

It is a safe assumption that two-thirds of the varieties now in cultivation, if excluded therefrom, would bring about a marked increase in average yields.

Assuming that the five provinces previously referred to are planted with an assortment of varieties as represented in the foregoing table, we can prepare a hypothesis which will be fairly representative of the effects actually resulting from the culture of a multiplicity of varieties.

The average production per hectare for these provinces in 1914 was 20.8 cavanes per hectare. To that average 17.6 per cent of the varieties contributed an average yield of 10.98 cavanes per hectare, which corresponds with those listed in the above table as yielding less than 1,000 kilos per hectare; 39 per cent of the varieties contributed an average yield of 24.34 cavanes per hectare; this class corresponds with the one listed as yielding more than 1,000 but less than 2,000 kilos per hectare. The remaining class of 43.4 per cent yielded at the rate of 27.08 cavanes per hectare, which brought the average up to 20.8 cavanes.

Since the exact area planted with each class is not known, a liberal assumption would be that only 13.4 per cent of the area was planted with the poorest-yielding varieties (although there is no doubt but that this figure is very low indeed), 44.5 per cent planted with the medium varieties, and 42.1 per cent of the area planted with the best-yielding varieties.

The estimated yield was 8,987,729 cavanes at the rate of 20.8 cavanes per hectare.

Thirteen and four-tenths per cent of the entire area yielded 635,819 cavanes because it was planted with the poorest-yielding varieties. If medium varieties had been planted the yield would have been 1,409,456 cavanes and if the highest-producing sorts only had been used, it would have been 1,568,122 cavanes.

Had the entire area been planted with only the most-productive varieties the total yield would have been 11,702,378 cavanes.

The loss in yield due to lack of productivity of varieties amounts to 2,714,649 cavanes which would have had a value of ₱6,780,000.

It is our opinion that even though the above ilustration is one constructed on a more or less theoretical basis the yearly loss due to planting poor-yielding varieties greatly exceeds the figures given.

As another illustration, we refer to the average results obtained with a large number of varieties in an experiment extending over a period of several years, on soil of very moderate fertility and with but one seedling to the hill, in which an average yield of approximately 40 cavanes per hectare has been uniformly harvested.

It would be a pleasure to be able to state that all rice land was given thorough culture before the crop was planted. In certain districts and again with certain individuals, thorough culture is the rule. Nevertheless, a large part of the rice lands is neither well plowed nor sufficiently harrowed. This is sometimes due to lack of animals but oftener due to the fact that the farmer does not appreciate the significance nor importance of reducing the soil in the rice fields to a fine condition of tilth.

Some preliminary investigations to learn the value of an extra harrowing given the soil just before transplanting takes place, indicate that greater gains than anticipated will result from more intensive cultivation of the soil. When the nature and character of the rice plant is understood it seems quite natural that the fine root system is better suited in a finely tilled soil where it can easily acquire the food required for the rapid development of the plant.

The matter of fertilizing rice soils has not yet been seriously considered by our rice farmers. Indeed, many of them seriously object to the application of cattle or horse manure, on the ground that the use of such material increases the weed growth in the fields.

Where the rainy season is short, there is very little opportunity for growing green manuring crops, nor leguminous crops to be planted after the rice is harvested. Reports on the use of chemical fertilizers vary greatly and unless such trials are very carefully handled the results may be exceedingly misleading.

There is much rice land which has not been cultivated for years and a great deal of virgin land that is being brought into cultivation. As long as land is a cheap commodity, the interest in maintaining or in increasing the fertility thereof is likely to receive scant attention.

The lack of irrigation facilities is a great handicap to the Philippine rice farmer, and until a great deal of rice area is placed under irrigation systems he will suffer more or less loss on account of periodic droughts, even though he puts into practice the best methods of seed selection, soil preparation, fertilization and culture.

It is an open question if a stable industry can be established without irrigation. With more or less expensive irrigation systems to sustain it is probable that more attention would be given to the culture of the crop, and, with control of water, the farmer would be assured of more uniform returns for labor expended, and would place a higher value on his tenure on land.

The lack of irrigation facilities looms very large among the factors contributing to low yields, but quite unfortunately it is the one factor which is most difficult and expensive to change.

On the other hand it is a very easy and inexpensive proposition to discard varieties which are not adapted to average meteorological conditions and to plant instead more suitable ones. The same applies to low-yielding varieties. It is also possible to more thoroughly work the soil.

THE RATE OF SOWING NURSERY BEDS; THE AGE OF SEEDLINGS WHEN TRANSPLANTED; THE INFLUENCE OF EACH.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

What is the proper quantity of seed to use on the seedbed? There are two views on this subject: one favors a small bed sown thickly, because it is cheaper to prepare and care for a small area, while the other favors a large area more thinly sown so as to secure more vigorous seedlings for transplanting.

The relative value of strong stocky seedlings compared with more tender, slender, or "leggy" plants with reference to their respective influence on ultimate yield is not easily determined, and only after a long series of carefully conducted tests would one be able to positively recommend definite rules for the best methods of preparation and treatment of nursery seedbeds.

Nevertheless the following data are offered for the consideration of others interested in the subject.

In 1913 a small experiment was carried out, employing a 140-day variety of rice and sowing the seedbeds with varying amounts of seed.

One-twentieth of a hectare was the standard area of seedbed determined upon and seed was sown at the rate of 2, 1.5, 1, 0.75, and 0.5 cavanes on this area.

There was no appreciable difference in the rate of germination of seed, which was found to be 75 per cent.

The seed was sown July 3 and a survey made of the nursery beds on July 24, three weeks afterwards.

The number of seedlings per seedbed was estimated by counting the seedlings on selected representative square decimeters, the average results being the basis on which the total population was computed.

According to the amounts sown the census was as follows:

Number of cavanes sown per 1/20 hectare.	Number of plants.
2	4,050,000
1.5	3,450,000
1	2,200,000
0.75	1,850,000
0.5	1,300,000

Practically no difference in height between the several plots was noticeable at this time. The inspector in charge of the work states that in his opinion all the seedbeds except the one most thickly sown were too sparsely populated and that even that one should have had about 12 per cent more seed.

The same scheme of sowing seedbeds was repeated at another point, and the comment made regarding this trial is as follows:

Observations made when the seedlings were ten days old and again when they were twenty days of age disclosed but little difference in the height of the seedlings in the most thinly sown beds when compared with those most thickly sown. The slight differences perceptible were to the effect that the former were slightly shorter and stockier.

At thirty days of age the seedlings in the two most thinly sown beds were coarser and more stocky than the others, and somewhat shorter. At forty days of age, the average heights of seedlings in all plots were practically the same, but in the plots where 2 and 1.5 cavanes of seed had been sown, the plants had smaller leaves and more slender stems, also in the centers of the plots the plants were inclined to lodge. The vigor and size of the seedlings progressed according to the scantiness of sowing.

It would naturally be anticipated that the stocky and sturdy seedlings would have an advantage over the more slender ones when transplanted, which would show a decided influence on the ultimate production of seed. This is not borne out by results so far secured. The average yield of one variety with seedlings from beds sown at the rate of 2, 1.5 and 1 cavanes to 500 square meters of seedbed was at the rate of 0.180 kilo per square meter compared with the yield of 0.133 kilo secured with the more sturdy seedlings taken from the seedbeds sown at the rate of 0.75 and 0.5 cavan per 500 square meters. With another variety the ratio was 0.258 kilo to 0.209 kilo, in favor of the more slender seedlings.

That there was any marked difference in the appearance of the seedlings grown in the three most thickly sown plots was hardly to be expected since relatively they were subjected to similar environment, so that the seedlings did not develop lateral shoots before being transplanted. It was quite apparent that they had fairly well exhausted the available plant food in their feeding area and the weaker seedlings were beginning to die or were already dead.

On the other hand, the seedlings in the beds sparsely sown developed quite differently, and it seems probable that a consider-

able difference in structure or development would have been found had the two types of seedlings been minutely compared.

It is commonly believed that the reason transplanted rice produces greater yields than does rice planted otherwise is due to the pruning process which takes place when the seedlings are withdrawn from the seedbed and prepared for planting, which injury to the root system brings about a reaction stimulating the growth of the sub-aerial portion and resulting in increased tillering. This theory does not take into consideration the fact that the seedlings when transferred to the newly cultivated field are removed from a position where the easily available food has, for the time being, been exhausted, to an environment where an abundance of food lies within easy reach; and in common practice there is retained a goodly portion of the roots which almost immediately resume their customary functions. Also these seedlings are transferred to a soil free from the toxic substances with which the original seedbed has been impregnated. Every farmer knows that no matter how carefully he replows and refits the seedbed, the plants set out therein do not thrive as they do in the common field, so it seems quite probable that toxins are at least partly responsible for the lack of vigor.

We have no desire to contend that the shock occasioned by the actual transplantation does not indirectly have a stimulating effect on the metabolism of the rice plant, but it seems that these other factors are more significant.

If in a seedbed the seedlings occupy not more than 2 square centimeters each, by the time they are five weeks of age there is practically no immediately available plant food remaining, the weakest ones succumb, and those surviving compete to the utmost for the plant food that is slowly being evolved. The root systems are not extensive nor is the leaf area large, neither is there any development of lateral culms. For the reasons stated these plants should suffer the least shock on being transplanted.

On the other hand the seedlings grown in the sparsely sown beds have when 5 to 7 weeks of age, a large leaf area and, of course, a correspondingly extensive root system, usually the first node having been formed and lateral culms having developed. When such a seedling is removed from the seedbed the shock to it is correspondingly greater because a larger proportion of its root system is lost, and, even though a considerable part of the leaf surface is removed, the relative bulk of plant remaining is greater than is the case with the previously mentioned sort of seedling. The shock to this stocky and sturdy seedling must be greater than it is to the slender and more delicate plant, and, if

the contention is well founded that the shock is the cause of the stimulus resulting in accelerated stooling or tillering, the well-developed seedling should possess a marked initial advantage.

It may also be said that, to a limited extent, the seedlings grown in the sparsely sown seedbed are somewhat pampered, while those grown in the thickly sown bed are subjected to a test for the survival of the fittest.

If rice is to be transplanted, it seems logical that this change should take place at such a time as tillering is due to begin, for, if given a stimulus at that time, it is reasonable to suppose that a greater extent of tillering will take place than without it.

Those who are familiar with sheep husbandry know about the "flushing process" practiced on the ewes in order to secure a larger percentage of twin offspring. It is not beyond the range of possibilities to assume that if this phenomenon in sheep, induced by means of super-complete nutrition, predisposes accelerated reprodution, a stimulus given a plant by means of abundant food supply will as well induce a similar result.

The tillering of a plant is only one stage of the act of reproduction and takes place within a definite period of its development. If at this time food is abundant, the plant will extend itself to the limit of its power to utilize this food. After that period is over it cannot respond to nutrition stimulus in this manner.

It is the writer's belief that, when the rice plant is more intimately understood, it will be learned that a provision of an abundant supply of available plant food, principally nitrogen in some form, will be regarded as essential at this stage in intensive rice culture, and that the farmer of the future will incorporate the idea in his practice.

While we do not regard the results we have secured as conclusive, our data reveal the fact that the ratio of stooling or tillering of seedlings grown in thickly sown seedbeds to that of seedlings produced in sparsely sown beds is as 14.8 to 10.5. In these studies the seedlings have not been continued in the seedbeds over 40 days.

This important point has more light thrown upon it when the effect on yield of the age of the seedling when transplanted is sought.

In order to secure some information on this point a test was carried out as follows:

A medium-early variety was sown in the seedbed on July 3, and plots were planted with seedlings therefrom on July 23, and August 2, and August 12, so that the seedlings were 20, 30 and 40 days old, respectively. Again, seedbeds were sown at ten-day

intervals so that at a given date seedlings of 20, 30 and 40 days of age could be transplanted into test plots simultaneously.

The results are given in the table below and are representative of the several tests completed the first season.

Age of seedlings.	Days to maturity.	Days from transplanting to maturity.	Average— Length of culms.	Number of culms per stool.	Number of grains per panicle.	Yield of rough rice per square meter.
			Cm.			*Kilo.*
20 days	132	112	122	4.35	100	0.203
30 days	137	107	121	4.30	96	.171
40 days	139	99	124	6.20	88	.179

A repetition of this experiment with three varieties yielded the following results. These varieties mature within 142 days on the average.

Variety and age of seedlings.	Days to maturity.	Days from transplanting to maturity.	Average— Length of culms.	Number of culms per stool.	Number of grains per panicle.	Yield of rough rice per square meter.
No. 629:			*Cm.*			*Kilo.*
20 days	115	95	99	11.2	94	0.083
30 days	126	96	82	12.1	99	.156
40 days	134	94	79	12.0	92	.160
No. 526:						
20 days	119	99	105	7	102	.142
30 days	130	100	91	8.2	108	.212
40 days	145	105	86	10.2	107	.164
No. 530:						
20 days	117	97	118	15.5	128	----------
30 days	126	96	109	12.8	127	----------
40 days	137	97	105	12.5	126	----------

Still another experiment was made in which 70, 60, 50, 40, 30, 20 and 13-day old seedlings were planted in which three varieties were used having maturing periods of 136, 156, and 178 days respectively.

Only the relative yields are indicated.

Age of seedlings.	Yield per square meter. 136 days to maturity.	156 days to maturity.	178 days to maturity.
	Kilo.	*Kilo.*	*Kilo.*
70 days	0.016	0.016	0.061
60 days	0.112	0.162	0.147
50 days	0.112	0.131	0.028
40 days	0.167	0.056	0.049
30 days	0.085	0.085	----------
20 days	0.022	0.019	0.032
13 days	0.016	0.018	0.025

One can hardly come to any other conclusion from the foregoing than that the age of the seedling is itself not a guide to the determination of the most suitable time to transplant the seedlings, since their condition at that stage depends upon the manner in which they have been produced and varies accordingly. Also, if seedlings are transplanted at the proper stage of development, the importance of a given rate of sowing the seedbeds is of rather small consequence.

In bulletin No. 22 of this Bureau, "Rice Culture in the Philippines," page 23, the author thereof states, "For transplanted rice one cavan or 43 kilos of palay seed is sufficient for one hectare; When sown broadcast it requires one-half more;" on page 18 of the same bulletin, "One-twentieth of the area to be planted is required for the seedbed. * * * As soon as the ground is prepared the seed should be put on at the rate of 43 kilos (1 cavan) for each one-twentieth hectare of seedbed. Some use more and some less. The amount will be governed somewhat by the variety."

In our opinion these directions will, for the present, serve as a standard until such a time as it is definitely determined that thicker or thinner sowing of nurserybed has a positive effect on the seedlings which influences the ultimate production of seed.

It is a more difficult and complicated matter to make recommendations regarding the proper age at which seedlings shall be transplanted, and, while one is sometimes forced to make definite recommendations, it should be understood that very many practices in rice culture are as yet based on convention, and much careful research must be made before specific recommendations or instructions may be safely considered as authoritative.

Investigations with regard to rice culture have only just been begun, so that in most cases the results secured indicate the direction in which further research should be carried, rather than the establishment of positive facts. With the limited resources at our command we have touched upon many very interesting points sufficiently to show us the importance of laying out and definitely following given lines of research. We have learned to recognize some of the more common sources of error in experimental work and how to guard against them.

For instance, when two series of plots are transplanted at different dates, even if only a few days apart, the influence exerted by a slight difference in the weather during this short period may easily be sufficient to utterly destroy the value of the data obtained.

We have regarded 30 to 35 days as the most suitable age at

which to transplant seedlings of varieties maturing within 150 days. At the same time we have realized that it is quite probable that each variety has its own peculiar habit which would more definitely determine the proper time for its removal to the field, but the determination of this fact requires considerable time, and meanwhile one must be guided by the data available until better and more definite information is obtained. It has been our experience that the earlier varieties, when the transplanting is deferred too long, mature the central culm in advance of the lateral ones, so that the grain on these culms is lost and, besides, an uneven appearance is presented by fields planted with such seedlings.

Tillering is but one among other very important habits which the several varieties possess in a varying degree and, even if this is the most elastic method by which a plant adjusts itself to its environment, this habit is, according to our present understanding, an important indication of the productivity of the variety. If the tillering habit is curtailed by unfavorable conditions early in life, the effect thereof will probably extend throughout, but, on the other hand, if the plant is provided with an opportunity to fully exercise its tillering habit during the early period of its growth, provision is then made for the exercise of the other functions which are in turn dependent upon environmental conditions prevailing during the respective stages of development.

The plant should be allowed to exercise its tillering habits normally. That does not mean that it should have an unhampered opportunity to tiller to the limit of its capacity, but the seedling should be produced in such a manner and be transplanted at such a stage in its development that neither the early environment nor its condition when transplanted will tend to prevent the normal exercise of its capacity to tiller. The restrictive influences of lack of plant food or moisture, or in other words, competition in the field, will probably not have much serious effect, if any.

There is some relation between amount of tillering and production of seed, but it is more than likely that other development incidental to the act of tillering is of more importance. It seems, therefore, that we shall also be obliged to determine the proper stage of growth at which each variety shall be transferred from the nursery seedbed to the field.

ERRORS IN RICE FERTILIZER EXPERIMENTS.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

When an effort is made to increase the yield of any crop, the first aid sought is usually fertilization. Even primitive people recognize the difference in productive powers of soils, and an illustrative phrase, referring to "fat" land and "poor" land, is found in nearly every language.

There is no other single topic today in the field of agriculture which is given so much thought, discussion and investigation as that of maintaining soil fertility, or in other words, the feeding of crops.

In the treatment of nearly all staple crops, conditions are quite similar, such as providing for drainage, soil aëration, etc., but with lowland rice entirely new conditions are met with, and we have no assurance that a method found very valuable when practiced with wheat or barley, for instance, will be of any use whatever when applied to rice grown in puddled, submerged soils.

It is a well-known fact that many so-called fertilizing experiments are unreliable because the investigators in charge of the work have failed to realize the significance and effect of other factors bearing on results obtained. Thus we find lengthy discussions leading to quite final conclusions, even though the condition and status of the soil with regard to initial content of plant-food elements is unknown; the degree of soil acidity undetermined; the previous cropping of the soil disregarded; and countless other more or less important factors overlooked.

We have in mind a paper describing very definite results obtained in fertilizing lowland, or irrigated and transplanted rice. Various amounts of several sorts of animal manures were used but nothing is said about their actual composition; part of the land was plowed dry, then flooded and harrowed, while the remainder of the area was flooded first and then plowed and harrowed; and to complicate matters, neither was there any attention paid to the actual amounts of water applied nor was the area

planted on the same day. Yet the public is solemnly assured that the differences observed in yield were solely due to the effects of the fertilizers applied.

There is no desire to decry or criticize the efforts of those who are attempting to solve the problems involved in the feeding of the rice crop, or any other crop for that matter, for every definite knowledge on this subject is sorely needed.

One of the great wastes in modern agriculture is the unintelligent use of artificial and animal manures. Thus we find nitrogen being applied when not needed, and phosphorus withheld when nothing else is actually necessary; a complete fertilizer used when the neutralization of acidity would serve better, and so on.

Artificial fertilizers are, according to our present knowledge, very important factors in the economics of agriculture and present-day public opinion regards the increased use therof as a reliable indicator of high development of agricultural practices.

The writer desires to call attention to the necessity of exercising greater care in the management of experiments, the results of which are to be submitted to the public for their guidance.

As an illustration of the very misleading deductions which might be drawn from even a comprehensive experiment, a short description of such a one is given below.

A plot of ground which had not been cultivated for a year was selected, in which the soil was uniform in character and composition.

One series of the experiment was designed to indicate the effect of nitrogen alone in varying amounts and in combination with phosphorus or potassium and in combinations with both.

The same scheme was used with phosphorus and potassium, so that a large number of combinations were made, 38 in all. Sulphate of ammonia, acid phosphate, sulphate of potash and tankage were the materials employed. The chemical analysis of each was determined. The tankage was used only on two duplicate plots. Provisions were made so that water could be admitted direct to each plot and drawn off into drainage canals. As far as could be seen every precaution was made to provide uniform conditions, but there was one exception. Due to accident nine plots were set out July 29 and 30 and the others on August 7.

When harvesting was begun the lack of uniformity in duplicate plots was very discouraging, but it prevailed throughout. At

any rate, it was possible to consider the original plots as a class, the duplicate plots as another. The results were as follows:

Average yield of rough rice per hectare:	Kilos.
Unfertilized area	1,520
Fertilized area	1,483

Twenty-one per cent of the area was not fertilized in any manner whatsoever. It so happened that of the plots planted July 29 and 30, two were not fertilized, four had complete fertilizers, and three had incomplete fertilizers.

The area planted July 29 and 30 yielded at the rate of 1,745 kilograms rough rice per hectare, while the area planted August 7 returned 1,409 kilograms per hectare.

It is evident from the foregoing that the variation in yield was due to some other cause or causes than the influence of the fertilizers; yet it would be possible to put the data into such shape that it would indicate utterly misleading and erroneous conclusions.

CONSUMPTION OF RICE IN THE PHILIPPINE ISLANDS.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

Of late one is often confronted with the statement that the per-capita consumption of rice in the Philippine Islands is gradually falling off.

Those who have been closely observing the habits of the people claim that the consumption of wheat flour is increasing so rapidly and extensively that it will have a strong tendency to lessen the consumption of rice. It is, of course, a well-known fact that a few years ago, in the more out-of-the-way places, it was impossible to procure bread in any form, while now the bake-shop is found in even the most isolated sections. There is no doubt that the use of flour is increasing, but the question remains if the increasing use of flour has any effect on the consumption of rice.

The production of wealth in these Islands has been greatly accelerated during the last decade, the exportation of copra serving very well as an example of this. In 1899 the value of the copra exported amounted to ₱1,313,740; ten years later the figure was ₱13,315,480, while the high point attained in 1912 brought the amount to ₱33,029,498. The prosperity of the people has become general during the past ten years, wages have gone up and the field for profitable employment has been vastly enlarged.

Public works and railroad construction, the extension of industries such as mining and lumbering, the extension of Government service in many branches, thus providing large numbers of remunerative positions, the establishment of numberless new enterprises, etc., have, through providing more lucrative employment, had noticeable effect on raising the standards of living. It may be true that the increase in incomes has had less effect on dietic standards than on others, the improvement in housing, the purchase of better clothing and so-called luxuries having been perhaps the more common outlet for surplus earnings. Nevertheless, a certain amount of change in food is bound to be consequent upon more favorable economic conditions.

It is not necessarily the case that there should be a greater consumption of more expensive grades or qualities of staples, but there may be an increasd amount per capita consumed of staple articles of food of the prevalent grade or quality.

It has been argued that a population such as is found in these Islands does not consume as much rice as it should; that because much of it is found in places where not enough rice is grown for home consumption, the cost of transportation is so expensive that the price of rice becomes too high and other less desirable articles of food are substituted; that the increased use of flour, Irish potatoes or corn, if actually being consumed in larger amounts, is not a desirable change, and, therefore, any scheme by which a sufficiency of rice can be provided at reasonable cost is much to be desired and will result in an increased per-capita consumption of rice.

According to the census taken in 1903 the population of these Islands was 7,635,426. Using the method of computing population increase employed by the Bureau of Health we find the population in 1914 exceeding nine millon by a margin of some eighty-odd thousands.

It is not only possible but highly probable that the population now exceeds the estimate by a large figure. Due to better and more extensive enforcement of sanitary regulations, to the control of epidemics, and to better nourishment, it is reasonable to anticipate that the increase of population has been going on at a considerably greater rate than is assumed. On the other hand, the crop estimates may have sufficient range so that the error in one factor will counteract the error in the other.

The amounts of rice produced and imported, corn produced, and flour imported, are given in the following table:

	Rice imported.	Rice produced.	Corn produced.	Flour imported.
	Met. tons.	*Met. tons.*	*Met. tons.*	*Met. tons.*
1909	137,678	487,032		25,932
1910	184,620	528,054	144,353	29,492
1911	203,083	574,843	145,396	30,786
1912	260,250	325,429	214,473	40,148
1913	179,205	685,968	253,851	49,890
1913 (July to December)	49,562			16,221
1914	[a] 96,921	636,609	366,570	35,513
1915	[b] 183,267	[c] 500,000		

[a] Calendar year. [b] First nine months. [c] Estimated.

NOTE.—Production estimates are for years ending June 30.

In order to get a better idea of the bulk of rice annually consumed, the imports and estimated production are combined. The

per-capita consumption of rice, corn and flour is submitted in this connection with comment following below.

	Total rice.	Rice per capita.	Corn per capita.	Flour per capita.
	Met. tons.	*Kilos.*	*Kilos.*	*Kilos.*
1909	622,710	74.17	----------	3.09
1910	712,674	83.55	16.92	3.11
1911	779,926	89.77	16.78	3.55
1912	585,679	66.52	24.36	4.56
1913	865,173	96.72	28.38	5.58
1914	783,096	86.18	40.34	5.69

That the consumption of flour is continuous and progressive is clearly evident, and there is no indication that shortage or abundance of rice have any influence upon it.

It should be explained, however, that the importations of flour made during the period from July 1 to December 31, 1913, were included with the 1914 total.

There are several good reasons for assuming that with the unusually large importation of flour during the year ending June 30, 1913, a considerable amount was carried over into the next period. Nevertheless, it would be quite reasonable to suppose that the upsetting of business conditions following the beginning of the European war would operate to lower consumption both in 1914 and 1915, but under normal conditions there is no doubt about the figures submitted being indicative of true conditions.

Considering the consumption of corn, several questions arise. Generally speaking corn has been the famine crop, catch crop, or poor man's food, but the more recent educational work conducted and directed by the various Government offices has undoubtedly done much to change public opinion regarding this grain. From 1910 to 1914 the area devoted to the production of this crop increased 46 per cent and the yield per hectare 74 per cent.

Primarily the grain is intended for human food. Only a very little is used in the industries, and grain feeding of swine, cattle, horses and poultry is not so universally practiced as it might be. However, the large crops produced in 1912, 1913 and 1914 have in part and even to a considerable degree, from necessity, been utilized for other purposes than for human food. A certain amount of rough rice is always used for feeding horses and poultry, but if corn becomes much cheaper than rough rice, the corn will be subtituted for it.

In 1912, there was probably more corn used for human food than either before or since that time, but the amount of grain

utilized for other purposes has very materially increased each year thereafter.

According to one authority the Japanese consume 105 kilos of rice per capita per annum. Since they live in a colder climate and are more active people, they would require more than the people in these Islands.

The writer is of the opinion that 85 kilos of rice per capita per annum is the normal figure for the Philippines, but there is no doubt but that this figure would be larger if more favorable conditions prevailed.

To refer to the table, the figures given for 1911 as the amount of per-capita consumption of rice should undoubtedly be lowered by distribution to 1910 and 1912. The figure given for 1912 is too low, because a considerable portion of the total amount included in the import and production figures for 1913 should properly be distributed over the preceding period.

In computing the figure for 1914 the rice imported during the period from July 1 to December 31, 1913, is included for the reason that it represents the amount carried over in storage from the preceding period.

When we come to consider the 1915 figures we are confronted with an anomaly.

The rice crop of 1914–15 was very seriously damaged by an unusually severe drought which began about October first, and continued without hardly a break worthy of mention until July of the present year.

This drought cut down yields in the principal rice-producing sections to an unusually low point. The subsequent dry season was characterized by phenomenally intense heat over long periods.

The surplus rice carried over from 1914 was probably not of great consequence.

Naturally, it was anticipated that the importations of 1915 would break previous records, yet by October first only 183,267 metric tons had been received. The average rate of rice importation into the Philippines is 15,000 tons per month. This amount represents the average monthly receipt over a period of sixteen and one-half years.

By October considerable new-crop rice appears in the provincial markets and the amount rapidly increases weekly for the remainder of the year. The peculiar fact, however, is that the importation of rice does not always directly arise from the need for it here for immediate consumption or even for use at a rel-

atively distant date such as a matter of a few months. As a matter of fact, even though the new crop of rice was rapidly coming on the provincial markets, and reserves of rice lay in the warehouses awaiting an outlet, big shipments of rice were brought into the Philippines and distributed for which at the time there was no apparent need.

We faced an unusual situation a year ago which was generally recognized soon after the war between the European nations had been declared. This was that the Archipelago was dependent to a vital degree on its neighbors for a given amount of rice, which supply might be shut off, and at the same time, was experiencing an unprecedented drought which curtailed local production.

The need for action was very apparent and immediately a general food-production campaign was inaugurated by the Bureau of Agriculture in which several other Government offices participated. In this campaign the production of corn, sweet potatoes and vegetables was strongly emphasized with the result that never before had there been such a supply of vegetables in general as came upon the market in the succeeding season. This was a new element in the local food supply and one of considerable magnitude. At any rate, the amount of corn produced is estimated to be nearly double that of 1912. The effect on rice consumption of the abundance of vegetables remains to be determined but it seems that the abundant supply of both corn and vegetables lowered the demand for rice, especially during the early part of the year.

The total amount necessary to supply 85 kilos of rice per capita would amount to 784,721 metric tons for 1915. Of this amount 183,267 had been received by October 1, and there were, according to various reports, sufficient stocks on hand to render further importations unnecessary. Although the 1915 rice area was larger than for the preceding season the total crop was estimated to be 500,000 metric tons, which amount, if the estimate is correct, does not quite supply the usual quota per capita when the imported rice is added. The large corn crop was most in evidence during the first part of 1915 as was the produce resulting from the food campaign.

There is nothing to show that there is any tendency towards lessened consumption of rice by the human population. The abundance of corn is probably the means of increasing rice consumption instead of lowering it, for if corn is cheaper than rice, it will be used for purposes for which rice has formerly

been utilized with the result that the rice will be kept for actual consumption as food.

Flour, in the limited amounts used, has little if any influence on the average consumption of rice. Its use may be regarded as an addition to a still inadequate supply of food. Under good economic conditions its use will increase because of its convenience and because of the mere fact that it supplies a much-to-be-desired variety; also it will enter more and more into the composition of the more complicated dishes.

THE WEIGHT OF RICE GRAINS.

By H. O. Jacobson, *Chief, Plant Industry Division.*

It is not long since the question of the relative value of large-sized seeds compared with small-sized seeds was discussed with considerable interest. There was not much assurance to be had as to whether seed size was a stable transmitted character or not, but the assumption was that large seed was so much more preferable to smaller seed that considerable expense could be incurred in order to secure such material, which would surely be compensated for by increased yield.

Everyone is familiar with schemes and devices for making mechanical selection of large and heavy seed for planting, and the lengthy discussions on the subject are at least interesting.

More recently, less attention is being given the matter, and, according to the results announced by those who have been doing selection work within pure lines, the prospects are that relative seed size will soon be considered as of importance only with regard to the influence it may have on the early development of the plant after germination.

With rice very little attention has been given to the matter of learning the position or location of the largest grains on the panicle.

Japanese investigators assert that the largest, or to be exact, the *best* grains occur in the upper third of the panicle.

Dr. J. Van Breda de Haan, in Java, having examined seventeen varieties finds that fourteen of these have heavier grains in the upper half of the panicle.

In making these determinations the panicle was divided at about the middle of its principal axis in such a manner as to permit the division to be equal as to the number of grains.

The grains were weighed in the hull and also after the hulls were removed.

When the panicle was divided into three parts, the upper third was usually the heaviest.

In our work we have examined fifty-eight of our varieties.

The panicle was divided into three portions, the division being based primarily on the branches so as to have an equal number in each portion. Sufficient panicles of each variety were taken to provide a number of such magnitude that the weights per thousand grains would be reasonably accurate.

It was found that in 24 varieties the heaviest grains were found in the upper third of the panicle, in 20 varieties in the middle portion, and in 14 varieties in the base.

The mean figures for all weights taken show that the weight of 1,000 grains from the upper third was 25.86 grams, the middle, 25.62, and the base, 25.45.

There is a very slight difference in weight in favor of the grains from the upper portion of the panicle, which is anticipated when dealing with a large number of varieties, but after all, the knowledge of this fact is of doubtful value in the work of increasing yield. In the first place the weight per 1,000 kernels does not appear to be as stable a character as has been believed, and must therefore be affected by environmental conditions prevailing during the maturing period.

We have yet to learn if the weather and the plant-food supply are not the cause of the difference observed in the weight of grains in the different portions of the panicle.

The observations made by Dr. Van Breda de Haan with regard to the fact that the grains on the secondary axes are heavier the nearer they are to the principal axis, agree with observations made here.

A table giving the names of varieties and the weight per 1,000 grains in grams, according to position on the panicle, is appended.

In the opinion of the writer, the question of seed size is of slight importance compared with other problems yet unsolved.

Table giving the names of varieties and weight per 1,000 grains in grams, according to position on panicle.

Variety name.	Weight per 1,000 grains in grams according to position on panicle.		
	Top.	Middle.	Base.
1. Alasan Diquet No. 1	23.10	25.18	25.20
2. Alasan Diquet No. 2	31.50	28.50	26.50
3. Alumisque	29.90	30.50	30.00
4. Bimmaka	30.00	27.50	28.70
5. Buntayug	19.76	20.85	20.00
6. Binanata	29.44	29.50	28.50
7. Bancado	27.00	25.90	26.55
8. Baro	21.15	22.45	20.75
9. Bandera	24.85	25.40	24.80
10. Balasang	23.95	22.90	23.75
11. Boncol	24.45	22.70	24.34
12. Bacculoy	25.00	23.85	23.74
13. Chayaket Kinol-long	24.83	24.83	25.05
14. Chayaket Likwet	25.70	26.94	25.54
15. Chayaket Cabugao	27.30	26.25	26.15
16. Chinaigo	23.58	23.95	23.75
17. Chayaket	27.61	26.50	28.15
18. Contenido	22.35	22.40	20.15
19. Canal	29.80	29.35	29.75
20. Chayaquet Immigan	24.37	24.05	23.05
21. Diquet Kuantian	25.70	25.45	27.95
22. Diquet Kayading	26.46	24.30	24.20
23. Daligan	24.70	26.62	26.76
24. Dalusun	21.25	21.27	20.40
25. Fiscal	24.10	26.00	26.68
26. Guepang	25.21	26.75	27.10
27. Gumguiriada	22.73	23.30	21.85
28. Gumiki	25.72	26.50	26.00
29. Ganado	23.90	24.85	23.28
30. Gracia	25.65	25.50	25.30
31. Inugnas	23.75	23.77	22.00
32. Immaramang	32.05	31.37	27.98
33. Kayading	32.13	31.15	33.15
34. Largavida	23.55	22.52	22.25
35. Lacay Diquet	29.15	27.45	25.71
36. Malatican	31.60	30.15	32.90
37. Malaga	28.95	28.45	25.35
38. Marimata	27.10	26.60	24.87
39. Murmuray	25.10	24.30	24.65
40. Maralisa	22.45	24.20	22.79
41. Mudson	20.20	21.30	21.32
42. Minantica	20.55	21.45	21.20
43. Oday	34.60	35.70	33.58
44. Pinili	25.00	23.65	25.79
45. Pugut Diquet	28.20	27.22	24.88
46. Pias	31.68	30.90	30.45
47. Quinatuday	26.68	25.83	26.25
48. Quiringquiruig	27.00	26.18	26.69
49. Sabor	26.00	24.90	27.66
50. Sabá	20.60	20.95	23.74
51. Saigorot	32.96	27.98	30.95
52. Sinaba	28.00	28.15	28.10
53. Sanglay	28.10	26.95	25.82
54. Sinana	21.25	22.25	22.02
55. Tiritir	21.50	22.46	22.10
56. Tiritir Nalabaga	24.83	25.50	24.60
57. Trauguilina	23.58	23.57	22.70
58. Yucan Diquet	22.17	21.17	22.59

AN EARLY REFERENCE TO PHILIPPINE RICE VARIETIES.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

In a volume published in 1854, entitled "The Commercial Products of the Vegetable Kingdom," of which P. L. Simmonds is the author, a reference is made to Philippine rice varieties which is at least of passing interest.

A Mr. Rich, a botanist of the United States Exploring Expedition, is credited with having supplied the descriptions of the following varieties:

Binambang.—Leaves slightly hairy; blumes whitish; grows to the height of about five feet; flowers in December: aquatic.

This variety is still grown in the Provinces of Rizal and Laguna.

Lamuyo greatly resembles the above; is more extensively cultivated particularly in Batangas, where it forms the principal article of food of the inhabitants of the coast: aquatic.

We have no data or record of such a variety and it is not now cultivated in Batangas, to our knowledge.

Malacquit.—This variety derives its name from its being very glutinous after boiling; it is much used by the natives in making sweet or fancy dishes; and also used in making a whitewash, mixed with lime, which is remarkable for its brilliancy, and for withstanding rain, etc.; aquatic.

Malagkit is a term designating the class. The word has a specific meaning—glutinous. Thus we have on record thirty varieties known ordinarily as Malagkit, but usually in conjunction with the specific variety name, as "Malagkit Kinastillo."

Bontot Cabayo.—Common in Ilocos, where it is cultivated both upland and lowland; it produces a large grain, and is therefore much esteemed, but has rather a rough taste.

The meaning implied by the name is that the panicle is like a horse's tail, therefore, having long awns. Although known to be found in Pangasinan, Zambales and the Ilocos provinces, it is not a popular variety now.

Dumali, or early rice.—This rice is raised in the uplands exclusively, and derives its name from ripening its grain three months from planting; the seed is rather broader and shorter than the other varieties; it is not extensively cultivated, as birds and insects are very destructive to it.

Dumali may be regarded as a class designation, although it is a specific name for one variety. The word or name implies early or quickly maturing. The variety referred to is still grown in Batangas Province.

Quinanda, with smooth leaves.—This variety is held in great estimation by the people of Batangas, as they say it swells more in boiling than any other variety; it is sown in May, and gathered in October; upland.

Kinanda is a well-known variety grown in Batangas and Cavite Provinces. There are six varieties of Kinanda and three more to which the name is applied as a descriptive adjective, as "Kinandang Puti."

Bolohan.—This variety has very hairy glumes; it is not held in much esteem by the natives, but it is cultivated on account of its not being so liable to the attacks of insects and diseases as most of the other upland varieties.

Buluhan signifies hispid. The variety known by this name is hardy but not very productive. The variety known by the specific name is found in Batangas Province but there are nine additional varieties in which the word Buluhan enters as a part of a compound name.

Malagcquit.—With smooth leaves, and red glumes (all the preceding are whitish); possesses all the qualities of the aquatic variety of the same name—that of being very glutinous after boiling. This rice, soaked in water with the hulls on, is said to be a remedy for worms in horses; it is given with honey and water.

Malagkit=glutinous (Tagalog).

Tangi.—Leaves slightly hairy, glumes light violet color. This upland variety is held in much esteem for its fine flavor.

This variety is not known to the writer. The name signifies that it is a special or unusual sort. It may be a case, however, of failure to distinguish between two very similar names. In Batangas Province a variety is still being cultivated which is called Tangui.

A PHILIPPINE WILD RICE.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

In December of 1913 our attention was called to a new species of rice, but the material then secured was inadequate for determination, so an attempt was made to obtain an entire plant and some mature seeds.

These were secured in April of 1914 in Gubat, Sorsogon. Mr. E. D. Merrill, botanist in the Bureau of Science, identified the species as *Oryza manilensis.*

In an article entitled New or Noteworthy Philippine Plants, VI, published in the August, 1908, number of the Philippine Journal of Science (botanical section), this species is described by Mr. Merrill as follows:

Oryza manilensis sp. nov.

Annua, erecta, 1 ad 1.3 m alta; foliis flaccidis, 10 ad 25 cm longis, 6 ad 7 mm latis; paniculis laxis, 10 ad 15 cm longis, flaccidis, paucifloris; spiculis 4 mm longis, arista 8 ad 10 mm longa.

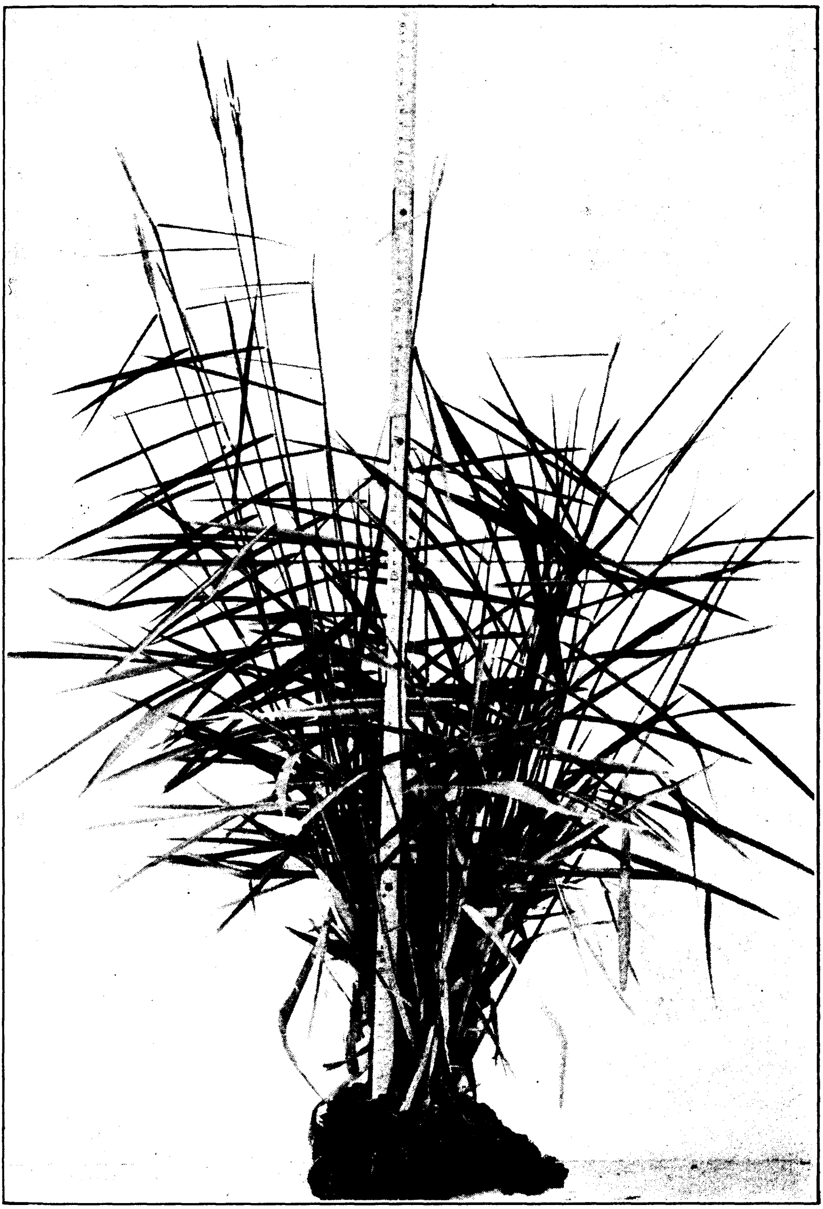
An annual 1 to 1.3 m high. Culms slender, glabrous, the nodes, 6 or 7, glabrous. Leaves flaccid, minutely scabrid when dry, 10 to 25 cm long, 6 to 7 mm wide; sheaths rather loose, shorter than the internodes, the ligules about 2.5 mm long. Panicles lax, 10 to 15 cm long, the branches slender, scabrid, usually drooping, few-flowered. Spikelets 4 mm long, the empty glumes narrowly lanceolate, acuminate, 1.5 mm long. Flowering glume oblong, granulate, spinescent-ciliate on the keel and ribs, its awn slender, straight, 8 to 10 mm long. Palea slightly exceeding the flowering glume, short-acuminate, spinescent on the keels.

Luzon, Province of Rizal, Antipolo, *Bur. Sci. 2194 Ramos,* March, 1907, growing in open wet places.

A species allied to *Oryza ridleyi* Hook. f., of the Malayan Peninsula and Borneo, differing from that species in its smaller spikelets, *fide* Hackel in lit.

The seeds of this species were sown in a nursery seedbed at the Alabang stock farm in June of that year, and it was given the same treatment and care as was accorded to other lowland rices.

At the end of the year there was no sign of flowering. The remarkable feature was its apparent resistance to drought, for the plot in which it was planted was repeatedly drained and the soil permitted to partly dry out yet there was little indication that this unusual treatment was seriously affecting the plants.



Philippine wild rice, *Oriza manilensis.*

Another lot of seed was planted this season and the plants are being carefully observed to note if the species possesses any truly valuable traits which would make it useful in hybridization.

The kernel of this species is very small and flat, in fact the smallest of any which has been seen by the writer. The kernel also has a red cuticle.

Agricultural Inspector Silverio Apostol reports upon it as follows:

The kernel does not develop well, being relatively small in comparison with the size of the glume. The germinating power of the seed is low and quite easily lost. When sown the seed germinates very slowly, sometimes as much as ten days elapsing before there is any sign of growth.

Growth is slow throughout but tillering is profuse, begining very early and continuing unusually late. New tillers were observed when some of the heads were exserted. The plants have a height of from 50 to 75 centimeters, measuring only to the base of the central panicles, but the culms vary widely in length.

The panicles appear at irregular intervals, so there is no uniformity in ripening. The heading-out period lasted fully a month so it is anticipated that the maturing period will be equally long.

As the seeds on the panicles ripen they drop off upon the ground. When not transplanted ripe seeds were gathered 85 days after sowing.

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SOME OBSERVATIONS ON CHINESE RICE CULTURE.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

A popular conception of Chinese agriculture is that it consists mainly of rice production. Yet the thirty-second parallel bisects China in such a manner that more than two-fifths of the area lies north of this line and in this portion but a negligible amount of rice is produced.

It is a sufficiently accurate statement to say that the thirty-second parallel marks the northern boundary of the rice country. If, in addition, Manchuria, Mongolia and Tibet are included as a part of China, which, as a matter of fact, is usually the impression that most people have, the rice territory of China dwindles to small proportions relatively speaking.

It is a common thing to read some paragrapher's statement that the rice-eating population of China is this or that number of hundreds of millions, but the truth of the matter is that the millions of Chinese who do not eat rice as a staple article of diet would make a startlingly large aggregate. It would be a splendid thing if the world could or would realize that China is a country of great magnitude; perhaps it should be added that some of the country's features are enormous.

Certain industries in China are of great antiquity, among which the rice-growing industry figures very prominently. It would be very easy at this point to start a controversy about the early history of the rice plant and the development of its culture, but this question is of little importance unless it may point the way to the discovery of wild species of rice which may be useful in producing new and superior varieties for modern culture.

The writer recently enjoyed the opportunity of making a few first-hand observations on rice culture in China, as it is practiced in the southern part of the Province of Kiangsu, and in the delta of the West River in Kwangtung Province. Judging by information gathered from sundry sources, these districts are representative.

The first distinct impression one receives is that no attempt whatever is made to cultivate rice on soil which is not particularly suitable for it. The habit of carefulness in adaptations of crops to soil and climate is not so marked with other crops, although it obtains to a high degree except in the culture of maize.

The rice fields are found only in the low, level districts, which are located in the river valleys and deltas. No littoral regions were visited. These soils are sedimentary, of fine texture and high initial fertility. Examples of sedimentation are apparent in every big river.

Given a soil of large proportions of silt and clay a prime requisite is had for rice culture. Lying contiguous to large streams of fresh water the problem of irrigation is more easily solved and it has been solved in these regions. The canals and creeks intersect this area so completely that practically all the land planted with rice is easily irrigated.

The value of a soil for agricultural purposes depends upon the original material from which it has been derived and the state of fineness to which it has been reduced; in addition, for rice culture, there must be added the availability of ample amounts of water for irrigation. These conditions are found to a highly satisfactory degree in the district visited.

It is evident that these areas have been cultivated for a long period, and the question of maintaining soil fertility is certainly interesting. It is hardly probable that there is much organic matter in these soils, the physical appearance indicating the contrary. This should be a splendid field for those who have in recent years been in controversy regarding the ethics of fertilizing, to gather evidence to support their several divers theories.

One very apparent condition regarding which anything is seldom said, is that the huge areas of uncultivated lands and the waterways and lagoons contribute directly or indirectly to the maintenance of the fertility of the cultivated lands. Thus the herbage from the hills and the aquatic plants from the waterways and lagoons pass directly into the soil of the rice paddies as green manure or compost. The waste from the fish and the manure from the animals fed with forage produced on the uplands, also passes into the cultivated soils.. When the high ratio of human population to animal population is considered, it is easier to understand how and why the use of night soil for fertilizer has become so common a practice. The importance of animal manure is relatively slight in comparison.

We have heard much about the value of night soil as a fertilizer, but judging by the yields obtained, and the general appear-

ance of the crops viewed, it is the opinion of the writer that eventually it will be discovered that the practice must be amended to include the addition of certain elements in the form of chemical or artificial fertilizers to make maximum production possible.

To one who is accustomed to the large number of varieties of rice which abound in the Tropics, the small number found as the northern limits of the rice region is approached is a feature that is appreciated. One of the greatest contributing factors to low yields and wastes in milling is the multiplicity of varieties which obtains in the tropical rice area. The number of varieties of rice grown in the district visited is much larger than it should be.

The appearance of the fields indicated that the soil had been very thoroughly prepared, and at harvest time the absence of weeds of all sorts was remarkable.

Irrigation is continued much later than is ordinarily considered essential. In many cases water was being applied when the harvest was due within two weeks. There appeared to be but one way of raising the water from the canal, creek or lagoon, and that was by means of an endless wooden chain running in a trough, operated by a treadmill, or, in other instances, by a bullock or water buffalo, hitched to a big bull-wheel directly connected to the shaft in the upper end of the trough. This type of apparatus for raising water is almost identical with devices seen in Japan and in the Philippines. As a rule, the water is raised but a short distance, rarely exceeding four feet.

The spacing of hills in the fields was uniform and seldom exceeded 20 centimeters between hills. In some fields the spacing was closer but the figure mentioned appeared to be the average distance. The number of bearing culms per hill was also quite uniform, the number most commonly appearing being nine, ten and eleven. As nearly as could be ascertained, the number of seedlings set in the hill would range between three and five. There were very few missing hills and but very little evidence of resetting. The number of grains per panicle very frequently was found to be less than a hundred, but panicles were also found which exceeded that number. The kernel type most prevalent was short, broad and thick, white and non-glutinous. This type is very different from the one represented by Saigon rice appearing in the Manila market.

There were a number of awned varieties and with regard to color of hull, as great a range from pale straw color to black as could be desired.

In the Philippines, lowland rice rarely is less than 100 centimeters in height. The prevailing short straw in the district visited was very noticeable in contrast, since many large areas covered with apparently normal plants had not a hill in which the culms were a meter long.

The writer was informed that the season's crop was the best produced in five years, and if that was the case, the general characteristics observed should be approximately normally developed.

The rice harvest begins in the north and proceeds southward by easy degrees, which is in direct contrast with the wheat harvest in North America, which begins in the south and proceeds northward.

The usual implement used in harvesting is a small sickle with a blade of 15 centimeters in length, attached at right angles to a wooden handle about 20 centimeters long. The harvester cuts a hill at a time, and, if the soil in the field is sufficiently dry, lays it flat on the ground. The usual practice is to cut several rows of hills at the same time, cutting the straw very close to the ground except the one outside row. The outside row is cut about 10 centimeters above the surface of the soil and the handful of rice plants from each hill is laid crosswise of the rows so that the panicles rest on the outside row of stubble. When the field is cut it presents a neat display of windrows, the heads all on one side, slightly raised, and the straw lying neatly and evenly. The crop is allowed to lie until it dries sufficiently so it may be threshed. At that time of the year there is little likelihood of rainfall, so the practice is quite safe.

Certain sections of this district are subject to frequent overflows and then the harvest method is slightly changed. Instead of putting the handfuls on the ground, small sheaves are loosely bound and these suspended on wooden tripods which are set up in the field as the harvesters proceed.

In the Philippines we find it possible to plant a much larger area with a given number of laborers than can be harvested, and, for this reason, many rice farmers select an early, a medium and a late maturing variety for their fields. This practice is also found in China. The rice farmer who has land subject to overflow, plants different varieties so the harvest will be extended over a sufficiently long period that he may handle it with a minimum supply of equipment and with his own labor. It is nothing uncommon to see three or more varieties growing side by side in a field of one-tenth of a hectare.

The unit of land measurement is the *mow* which is equivalent to one-sixth of an acre. To be exact, the legal mow contains 7,260 square feet, but among the Chinese a mow containing but 6,600 square feet is sometimes found, and it may be imagined that the latter size is the one used when yields are computed or land is being sold.

Just as soon as the panicles are sufficiently dry so that the grains will shatter easily threshing begins. There are three principal methods. In one case a large heavy wooden box, widely flaring and mounted on runners is taken to the field and moved from place to place as required. This box can accomodate four threshers. A large handful of the grain is grasped near the butts of the straw and the grain is removed by beating the panicles against the inside surface of the flaring box. The grain falls down towards the center of this box from which it is removed and carried to the farmer's house in sacks or baskets. When another method is employed the loose grain is made up into large bundles and carried to the farmer's house either on the man's own back, or packed on donkeys, bullocks or carabao, or carried by boat, or wheel-barrow. The threshing floor, which is a convenient term, but misapplied in this case, is located close to the farmer's house. Sometimes the flaring box is used but usually a small slanting table on four legs, the surface of the table consisting of wooden slats, is employed. Only one operator can work at each table and he removes the grain by beating the heads against the surface of the slatted table. The grain falls through into a box or basket, or on a mat or the earth as the case may be. Where the amount of grain to be handled is considerable, a threshing floor is made either of baked clay or of stones. The loose grain is strewed about on the floor and a large, tapering corrugated stone roller is drawn about over this material. The roller may be drawn by a water-buffalo, bullock, or by men and women. Occasionally, the roller is smooth and not tapering, but the advantage of using the tapering, corrugated roller is quite obvious. It tends to travel in a circle of a given radius for one thing. Sometimes the animal hitched to this roller is encouraged to move by ingenious means. A common scheme is to suspend a bundle of nice succulent grass barely beyond the animals head and in his futile attempts to acquire this tidbit he proceeds to move around the threshing floor in a highly satisfactory manner. Another scheme is to tie a bundle of grass on one side of the animal's head so that in trying to eat the grass he tends also to move towards the center of the floor and travel in

a circle. After the grain is threshed it is spread out on mats in the open to be sundried sufficiently to prevent heating in storage.

A most unusual crop is sometimes gathered immediately after the rice is taken off. This crop consists of bricks. Where the soil is of the proper texture, the rice stubble is shaved off even with the surface of the soil and a knife is run through the soil lengthwise of the plot, cutting the soil into narow strips of uniform widths. These strips are cut into sections and a trench dug next to the first strip. The knife is then run along underneath and the bricks carefully removed one by one and neatly laid out in the sun to dry. When the bricks are sufficiently dry to permit handling they are piled in ricks for further treatment. This is a case of making bricks without straw, but the numerous fine roots of the rice plant in the soil is a very good binder and serves the purpose admirably.

The feature of greatest interest is yield. Estimates on various fields were given, ranging from 160 to 300 catties per mow. A catty is equivalent to one and one-third pounds avoirdupois, varying slightly according to the three standard catties. These estimates are equivalent to 1,278 to 2,400 pounds per acre or 28.4 to 53.3 bushels of rough rice.

The above figures are regarded as conventional, since in the writer's opinion the yields had a wider range. Many fields did not yield as much as the indicated minimum, and several fields gave every indication of producing considerably more than the maximum. Here, as in all communities, was evidence of difference in the skill and application of methods, according to the individuals. There is not much variation in the methods employed but a great difference in the thoroughness in the application of methods. It was clearly evident that, in one case, we saw the results produced by a good farmer, in another, those of an indifferent one, and again, the pitiful results produced by the inferior farmer.

In places was noted splendid uniformity of seed, in others the fields showed mixtures of varieties hopelessly inferior.

In the south, notably in the vicinity of Canton, the spacing of hills is more open, the distance often being as much as 40 centimeters but more seedlings are placed in the hill.

An easy method of irrigating was noted in this district. The lands bordering on the river are apparently more recently formed. At any rate, they lie below the level of the river at high tide. Consequently, when the high tide raises the river water level, the water overflows these rice lands and remains several hours, but

as the tide ebbs the water flows off again. This is the least expensive irrigation scheme on record.

In general the rice industry, at least in the regions visited, appears to be standardized to a considerable extent. Through centuries of experience it has been determined that certain lands are most suitable, certain practices reliable and given methods most productive, hence there is but slight variation when one district is compared with another.

It appears that the need is for more rice to feed the people, and this need cannot be met by any revolutionary changes in the industry. The way out lies in the elimination of poor varieties now in culture and the evolution of more productive varieties to be grown instead. That there is a great opportunity along these lines no one who is at all familiar with modern agricultural science doubts.

RICE CULTURE IN CALIFORNIA.

By H. O. JACOBSON, *Chief, Plant Industry Division.*

We have read with interest Farmer's Bulletin No. 688 "The Culture of Rice in California," published by the United States Department of Agriculture, which has just come to hand.

It is stated that the Office of Cereal Investigations inaugurated variety tests of rices in the vicinity of Biggs, California, in the spring of 1909, which were continued in 1910 and 1911.

In 1912 the Biggs Rice Field Station of about 23 hectares was established through coöperation with the Sacramento Valley Grain Association, an organization composed of ranchers.

The first commercial rice crop in California was grown in 1912, consisting of about 570 hectares. This crop was profitable and in 1913 the area was increased to 2,430 hectares, which produced an average yield of approximately 86 cavanes rough rice per hectare. In 1914, 6,478 hectares were planted which yielded to the growers an average cash return of ₱247 per hectare. Yields have varied, of course but in instances as much as 180 cavanes per hectare have been harvested.

The leading varieties are such as require six months to reach maturity and there is an eager desire for earlier sorts.

This bulletin contains much sensible advice and the summary is herewith quoted with a few omissions of matter not pertinent to our conditions.

Clay soil with an impervious subsoil, if it lies in level tracts and can be well drained, is well adapted to rice.

Shallow soils are preferable to deep soils, because less water will be required to submerge them.

Rice requires an abundant and always available supply of water.

On typical adobe, and probably on all of the clay soils on which rice may be grown, it may be necessary to apply water to germinate the seed. Great care should be taken in irrigating to obtain germination. Before the plants emerge, water should not be allowed to remain on the land longer than 24 to 48 hours after each irrigation. After planting, the soil should never be allowed to dry out. The water should be applied not less than 4 inches deep, and preferably from 5 to 6 inches, and should be applied approximately 30 days after emergence.

The field should be rapidly drained when the heads are well turned down.

The growing of rice on soil that is simply kept moist and not submerged is not to be seriously considered.

More data must be obtained before definite statements can be made regarding the quantity of water that may be necessary to produce a crop of rice under California conditions.

Field and outside levees should be permanent and accurately located.

Poor drainage, or the lack of drainage, results in underproduction through the waterlogging of the land and the accumulation in the surface soil of harmful salts, commonly called alkali.

Rice should be cut promptly when ripe. If exposed too long to the sun the ripe grains are likely to become cracked, which will cause heavy breakage in milling.

Early-maturing varieties of good quality that will produce high yields are needed to protect the crop from the probable losses through high humidity and rain, which increase as the harvest period is delayed.

Barnyard grass is the worst weed to be found in the rice fields of California. It has taken possession of more than 2,000 acres of rice land in the Sacramento Valley and is now present in alarming quantities on a considerable acreage, which will soon be rendered unprofitable for rice growing unless active steps are taken for its complete eradication or control. Seed rice containing the seed of barnyard grass should not be used. When present in a field in small quantity it should be removed by hand. A rotation of crops, including a cultivated one, and summer fallowing may be employed as the best means of obtaining the complete eradication of this weed.

CURRENT NOTES—FOURTH QUARTER.

NOTES BY H. O. JACOBSON, Chief, Plant Industry Division.

CORN CONSUMPTION.

At the Fiftieth Congress of the American Chemical Society held at New Orleans, March 31 to April 3, 1915, E. T. Berford, president of the Corn Products Refining Company, submitted a communication giving some very interesting information regarding the disposition of a huge amount of corn (maize).

It is stated that 50 million bushels of corn are now annually consumed in the industries and converted into the following products:

	Millions of pounds.
Corn sirup	800
Starch	600
Corn sugar	230
Gluten feed	625
Oil	75
Feeding cakes	90

There are additional minor sub-products. According to the report contained in the Monthly Bulletin of Agricultural Intelligence and Plant Diseases (Rome) the progress in the mode of preparation enables the corn (maize) products to compete with those of wheat, sago, rice, etc., the products of which are limited to starch, and liquid and solid glucose.

The Philippine corn crop of last year amounted to 366,570 metric tons of shelled corn and for the first time in recent years the prices were sufficiently low so that corn could have been purchased here for sale in foreign markets.

For the present, there is no outlet for any surplus corn, but if the industry is to progress and attain the proportions it is easily capable of, some means must be provided for quick and easy disposition of such portion of the crop as is not needed for human food or for the feeding of animals.

It is highly improbable that the United States will permit the entry of Philippine corn, due to the presence here of the fungus disease commonly spoken of as corn blight, therefore it will be necessary to turn to the European markets, which have already accepted corn from blight-affected regions.

Finding an export market for our surplus corn is a business proposition, which can undoubtedly be easily managed. Problems which will arise in connection with the preparation of the product for export have already been solved elsewhere and this information can be readily secured.

The growing consumption of corn in the industries is encouraging news for regions such as the Philippines, which have great potential capacity to produce this crop.

RICE INVESTIGATIONS.

The literature of tropical agriculture is filled with material on the subject of rubber, sugarcane, coconuts and cacao, and minor crops have had considerable attention, but the most important crop of all—rice—has only very recently been given serious attention.

Today, we find systematic investigational work with rice being done in Italy, Japan, India, Indo-China, Java, British Guiana, Ceylon, United States of America, and elsewhere, the countries of the subtropics or sub-temperate regions being first in the field while the countries in the Tropics have entered later.

It is perhaps unfortunate that the rice industry has been neglected so long, but, the work that has been done on barley, wheat and oats has a broad but useful application to the problems in the improvement of rice and can be and is being adapted thereto.

RICE EFFICIENCY STANDARD.

Percy A. Hill, a practical rice grower in the Province of Nueva Ecija, P. I., employs an efficiency standard by which he judges the men he employs. After taking into consideration the quality of the soil, the water supply and weather conditions, it is believed to be more of a personal or man-factor that makes the differences in yield, than is commonly supposed and this assumption is borne out by the records kept and appears to be correct.

In his region the standard is set at 200 cavanes or 8,600 kilos per man and it is surprising how closely this standard is approximated or even exceeded year by year. The hectare yield is estimated at 84 cavanes or 3,612 kilos rough rice, which is practically four times the average yield per hectare for the entire rice area of the Philipines.

This brings up the economic question of the relative importance and significance of return per unit of area cultivated compared with the return per man employed. This topic has

been freely discussed by the corn (maize) growers of the United States, also by the growers of small grains, and has resolved itself into approximately the following: Where land is suitable and abundant and labor scarce the per-man-yield is most important but where the opposite conditions prevail the per-unit-of-area-yield comes first. With lowland rice, due to the expense involved in diking and supplying irrigation water the per-unit-of-area-yield will require first consideration, even though there is much raw land available at low initial cost.

NUMBER OF SEEDLINGS AND SPACING OF HILLS IN RICE CULTURE.

In the Annual Report of the Agricultural Stations of Bihar and Orissa (1913–14) N. S. McGowan submits the following conclusions regarding the number of seedlings to be set in the hill and the spacing of hills.

Spacing hills about 40 centimeters apart seemed preferable to spacing at 15, 22.5 or 30 centimeters. Four seedlings per hill gave the largest yield generally, but with very heavy applications of animal manure one seedling per hill equalled or exceeded the others in yield. Other hills contained 2, 4 and 6 seedlings each.

NUMBER OF TILLERS AS AFFECTING THE WEIGHT OF GRAINS IN RICE.

E. Thompstone, in the Agricultural Journal of India, in an article entitled "Some Observations on Upper Burma paddy (grown under irrigation)," states that as the tillers increase there is an increase in the weight of grain but this increase is not in proportion to the number of tillers produced by the plant. He also reports that as the number of tillers increase in number the average yield per tiller decreases.

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The Philippine Agricultural Review

VOL. IX FIRST QUARTER, 1916 No. 1

SPECIAL ARTICLES

ONE YEAR OF THE FIBER-GRADING LAW

By M. M. Saleeby

DESCRIPTION OF THE STANDARD GRADES OF PHILIPPINE FIBERS

By M. M. Saleeby

A QUARTERLY PUBLICATION
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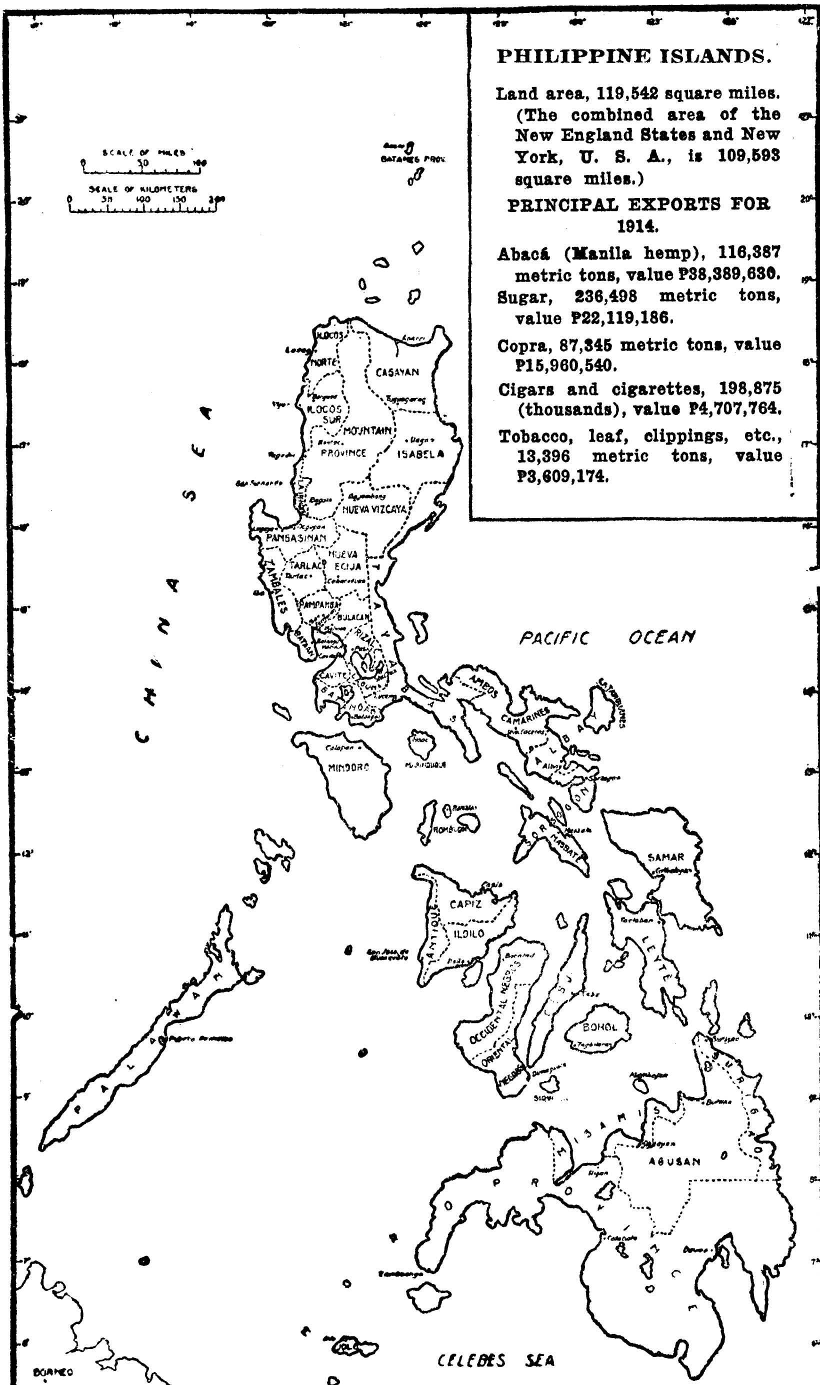

PHILIPPINE ISLANDS.
Land area, 119,542 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1914.
Abacá (Manila hemp), 116,387 metric tons, value ₱38,389,630.
Sugar, 236,498 metric tons, value ₱22,119,186.
Copra, 87,345 metric tons, value ₱15,960,540.
Cigars and cigarettes, 198,875 (thousands), value ₱4,707,764.
Tobacco, leaf, clippings, etc., 13,396 metric tons, value ₱3,609,174.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
PACIFIC OCEAN
CHINA SEA
CELEBES SEA
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
BATAAN
RIZAL
CAVITE
LAGUNA
BATANGAS
TAYABAS
AMBOS CAMARINES
CATANDUANES
ALBAY
SORSOGON
MINDORO
MARINDUQUE
ROMBLON
MASBATE
SAMAR
LEYTE
CAPIZ
ILOILO
ANTIQUE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
SIQUIJOR
PALAWAN
MISAMIS
SURIGAO
AGUSAN
MORO PROVINCE
BORNEO

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Illustrating method of baling abacá, after sorting and grading.

FIBER NUMBER

THE PHILIPPINE

Agricultural Review

VOL. IX FIRST QUARTER, 1916 NO. 1.

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THE ABACÁ INDUSTRY.

The condition of the Philippine abacá industry two years ago was one which fully justified the gravest apprehension. For a period of nearly a century abacá has been an export product of the Philippine Islands. Starting in 1818 with the shipment of about three hundred bales of fiber, the production has steadily increased until, at the present time, more than one million bales of abacá are exported from the Islands each year.

The value of abacá exports represented, for a number of years, approximately two-thirds of the total value of all Philippine exports. With the increasing production of other staple crops, the relative importance of abacá has decreased, but it still remains the leading export product of the Islands. In many sections of the Philippines abacá is the one crop of importance, and thousands of families are entirely dependent on this crop for a livelihood. Under these circumstances the importance of maintaining the abacá industry in a prosperous condition, and of providing for the continued development of this industry, can be readily understood.

For more than a decade there had been an increasing amount of dissatisfaction on the part of the manufacturers, both in the United States and Great Britain, with abacá fiber. This dissatisfaction was largely due to the fact that no uniform system of grading abacá was in existence. Each exporter had his own system of grading and his own system of house marks. As a result of this situation there was a great deal of confusion and misunderstanding in the foreign markets, and manufacturers were frequently unable to obtain at a reasonable price the quality and quantity of fiber desired. The alternative was to purchase and use other fibers.

With a view of remedying this situation the Third Philippine Legislature, on February 28, 1914, passed an act providing for a Government system for the inspection, grading, and baling of abacá, maguey, sisal, and other fibers. This law became operative on January 1, 1915.

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This system has now been in operation for one year, which is a short period of time in which to effect a complete change in methods that have been in general use for a century. The establishment of the Government scheme of grading and inspection of all fiber exported from the Philippine Islands was a radical change from the system that had been in use for generations, and it was not to be expected that such a change could be made without a certain amount of friction.

It is not claimed that the Government system of grading and inspection is perfect, or that it cannot be improved. It is claimed, however, that this system has already materially improved the condition of the Philippine fiber industry—a claim that is fully substantiated by the statements of prominent producers and consumers of abacá. It is believed, furthermore, that with continued improvement this system will be strongly supported both by the producers and the consumers of abacá, and that it will place the abacá industry on a secure and stable basis.

GRADING AND BALING PHILIPPINE FIBERS.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS,
DEPARTMENT OF PUBLIC INSTRUCTION,
BUREAU OF AGRICULTURE.

MANILA, P. I., *January 20, 1916.*

GENERAL ORDER }
No. 47. }

On and after April 1, 1916, and until further orders, the provisions, requirements, and regulations of General Orders Nos. 32, 33, 37, and 45, of the Bureau of Agriculture, shall be and are hereby amended and consolidated to read as follows:

In accordance with the provisions of Act 2380 of the Philippine Legislature, entitled "An Act providing for the inspection, grading, and baling of abacá (manila hemp), maguey (cantala), sisal, and other fibers," the following regulations, governing certain phases of the grading, baling, and inspection operations of Philippine fibers, are hereby issued for the information and guidance of all concerned:

These regulations cover three main subjects, namely (1) designation of the official standard grades for each fiber included in Act No. 2380; (2) determination of the standard grades and types thereof; and (3) additional regulations regarding baling, labeling, and inspection.

ARTICLE I.—*Designation of official standard grades.*

The following-named Philippine fibers are included under these regulations and a separate set of standard grades are established for each:

(1) Abacá (manila hemp): Well-cleaned fiber.
(2) Abacá (manila hemp) strips: Partially cleaned fiber.
(3) Abacá (manila hemp): Woody and waste fibers.
(4) Maguey and sisal: Retted.
(5) Maguey and sisal: Knife or machine cleaned.
(6) Pacol and Canton (wild banana).

SECTION 1. *Abacá (manila hemp)—Well-cleaned fiber.*—The following grades shall be the official standards of classification

for this fiber only when the product is in the form of fiber, i. e., well cleaned:

Letter designation.	Name of grade.	Letter designation.	Name of grade.
A	Extra prime.	S 1	Streaky No. 1.
B	Prime.	S 2	Streaky No. 2.
C	Superior current.	S 3	Streaky No. 3.
D	Good current.	G	Seconds.
E	Midway.	H	Brown.
F	Current.		

SEC. 2. *Abacá (manila hemp) strips—Partially cleaned fiber.*—There shall be five grades of abacá when the fiber is prepared in the form of strips, which shall be designated as follows:

Letter designation.	Name of grade.
I	Good fair.
J	Fair.
K	Medium.
L	Coarse.
M	Coarse brown.

SEC. 3. *Abacá (manila hemp)—Woody and waste fibers.*—There shall be six grades of abacá when the fiber is hard and woody, damaged, or in the form of strings or tow, which shall be designated as follows:

Letter designation.	Name of grade.
DL	Daet coarse.
DM	Daet coarse brown.
Y	Damaged.
O	Strings (white).
OO	Strings, coarse or dark.
T	Tow.

SEC. 4. *Maguey and sisal—Retted.*—There shall be four grades of maguey and sisal when the fiber is separated by retting the leaves in water. These grades shall be designated as follows:

Letter designation.	Name of grade.
Mgy or Ssl 1	Maguey or sisal No. 1.
Mgy or Ssl 2	Maguey or sisal No. 2.
Mgy or Ssl 3	Maguey or sisal No. 3.
Mgy or Ssl D	Maguey or sisal damaged.

SEC. 5. *Maguey and sisal—Knife or machine cleaned.*—The grades for either maguey or sisal when cleaned by machinery or by knife shall be three, designated as follows:

Letter designation.	Name of grade.
A	Mgy or Ssl, good.
B	Mgy or Ssl, fair.
C	Mgy or Ssl, common.

The initials "Mgy" and "Ssl," placed before the name of the grade, are abbreviations of the words "maguey," and "sisal," respectively, and their use is required more particularly in the knife or machine cleaned fiber. The private grader should, therefore, inquire as to the identity of the fiber from the producer, and affix the proper initials.

SEC. 6. *Pacol and Canton.*—These fibers are produced in certain parts of the Philippine Islands from plants, known by the same names, which resemble both the abacá and the banana. They are considerably weaker than abacá, and the adulteration of this fiber with one or both of the former is strictly prohibited.

There shall be two grades of pacol and canton, namely, *Pacol No. 1* (*PCL 1*), to apply to the well-cleaned fiber (white or dark); and *Pacol No. 2* (*PCL 2*), to apply to the strips or partially cleaned fiber (white or dark) of both of the afore-mentioned species. A further subdivision of these grades may be made in the future, if these fibers increase in importance and their trade conditions render such subdivision necessary.

The grading of these fibers shall be made under a separate lot number from that of abacá or maguey, and a separate certificate shall be issued for it by the fiber inspector.

ART. II.—*Designation of grades and types.*

The grading of fiber in the standards included in Article I of this order shall be based on its *tensile strength, color,* and *cleaning,* as follows:

Tensile strength.—This is a basic quality, and under this system the fiber must possess an average normal breaking strength in order that it may be graded to any of the standards established in this Order, otherwise, it will be graded as "damaged," irrespective of its color or cleaning. If the proportion of weak or damaged fiber in a lot is not sufficiently high to justify the above action, then the only recourse shall be the rejection of the whole lot for sorting the weak fiber from that of normal strength. Ordinarily, practical observation and hand tests are sufficient to indicate whether or not a certain fiber possesses normal strength. In cases of doubt or dispute, however, the fiber inspector shall verify his findings by making tests with adequate strength-testing machines provided by the Government for this purpose.

Color.—The tensile strength of a lot of fiber being good, the practical grading operation will be based on its color. This quality, therefore, is the determining factor of grading well-cleaned abacá and knife or machine cleaned maguey and sisal.

The color of the abacá fiber ranges from brown or purple to white, and the extent of variation allowable between one grade and another is illustrated by standard samples prepared by the fiber division and distributed to graders and buyers on request.

Cleaning.—The method, or extent of cleaning (fiber extraction), often produces radical changes in the character and usefulness of the fiber, hence the establishment of a separate set of standard grades for abacá strips and for retted maguey and sisal. In the grades included under these two sets of standards, the extent of cleaning is the determining factor, although color is also taken into consideration.

In describing the cleaning of fiber in the Certificates of Inspection the following terms will be used:

"Excellent," when the cleaning is perfect or nearly so, the product being pure fiber, as in the grades "Extra prime" to "Midway," inclusive; in the three streaky grades, in the three grades of knife or machine cleaned maguey and sisal, and in the grade "Maguey or Sisal No. 1."

"Good," in the case of abacá, when the product is somewhat strippy but the strips are fine, soft, and more or less intermixed with pure fiber, as in the grades "Current," "Seconds," "Brown," and sometimes "Good fair;" and in the case of retted maguey and sisal, when the fiber is to a small extent spotted with hard, gummy scales, as in the grade "Maguey or Sisal No. 2."

"Fair," in the case of abacá, when the product is distinctly strippy but the strips are narrow and thin, as in the grades "Good fair," "Fair," and "Medium;" and in the case of retted maguey and sisal, when the gummy scales on the fiber are more or less prominent, as in the grade "Maguey or Sisal No. 3."

"Coarse," when the product is entirely strippy, and the strips are wide, pulpy, or both, as in the grades "Coarse," "Coarse brown," and the two Daet grades.

In addition to strength, color, and extent of cleaning, there are two other characteristics in a fiber which do not affect its grade but are often considered necessary to identify its type in any of the grades. These are *texture* and *length.*

The *texture* of a fiber, in most cases, varies according to its cleaning. This will, therefore, be designated as "Soft," "Medium," or "Hard," according as the cleaning is "excellent," "good," or "fair" or "coarse." Some varieties of abacá in North and South Mindanao produce a fiber which is naturally of medium or hard texture, though it may be of excellent cleaning.

Under *length,* abacá fiber will be designated "long" when it exceeds $2\frac{1}{2}$ meters (8 feet) in length; "normal," when it is

$1\frac{1}{2}$ meters (5 feet) to $2\frac{1}{2}$ meters (8 feet); and "short," when it is under $1\frac{1}{2}$ meters (5 feet). Maguey and sisal will be designated "long" when 1 meter (40 inches) or more in length; "normal," when between 60 centimeters (24 inches) and 1 meter (40 inches); and "short," when under 60 centimeters (24 inches).

ART. III.—*Baling, labeling, and inspection.*

The following additional regulations regarding baling, labeling, and inspection of bales, shall be complied with by all grading establishments:

SECTION 1. Each hank in a bale shall not exceed 12, nor be less than 6 centimeters in diameter before pressing.

SEC. 2. The dimensions of each bale of the grades "Extra prime" to "Midway," inclusive, may be increased not more than 40 per cent over the measurements prescribed in section 5 (*a*) of Act No. 2380, only when the fiber is specially sorted and prepared for the manufacture of braid or similar fine fabrics.

SEC. 3. The division of each hank into two or three parts, and the twisting of these parts in a manner similar to the twisting of the strands of a rope, is prohibited. The hank may, however, be twisted once or twice as a whole sufficiently to keep the fibers together.

SEC. 4. The hanks shall be laid straight in the bale, the heads (butt ends) in one row, alternating with the tips (points) of the next row. The hanks shall not be doubled upon themselves more than is absolutely necessary.

SEC. 5. Each bale of fiber shall be securely bound with not more than eight side and four end bands, made of the same kind of fiber as that contained in the bale, or of bejuco (rattan). The outer bands shall not be nearer than 10 centimeters to the edge. (See fig. 1.)

SEC. 6. All fiber on being graded shall be divided into lots. The fiber in each lot shall be of a uniform type, but may be of more than one grade. The lots must be numbered consecutively, and a range of numbers will be furnished each grading establishment along with the grading permits, which numbers may be repeated on January 1 of each year. The inspection of a shipment of fiber shall be made on each lot separately, and a separate certificate of inspection given for each lot inspected. A lot of fiber shall be considered under inspection until all the bales of all the grades included in it shall have been stamped and the required certificate of inspection issued therefor.

In order to avoid unnecessary confusion and to obtain uni-

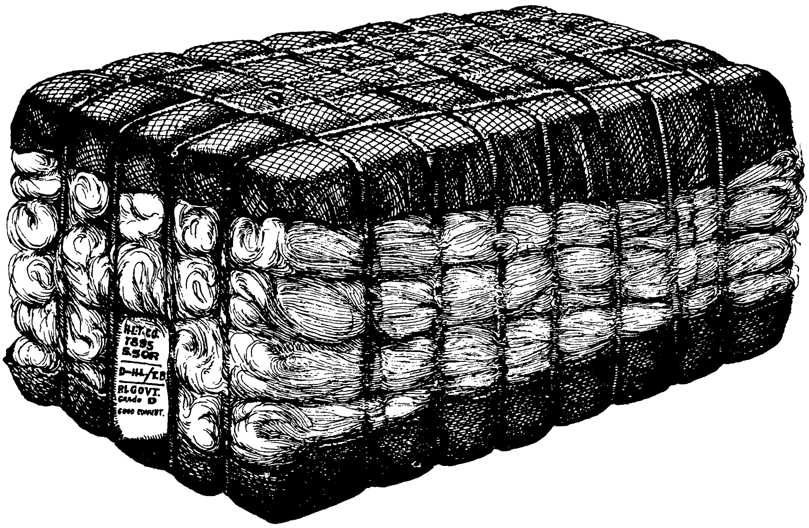

FIG. 1. The completed bale, showing method of wrapping, binding, and tagging.

formity of type, the attention of the graders is called to the necessity of dividing their lots in such a way as to have in one lot fiber which comes from one province or district only. Otherwise, any readjustment of lots may entail unnecessary trouble and expense to the grader.

In order to facilitate the division of fiber into lots uniform in type, the abacá provinces of the Philippine Islands shall be divided into the following districts, the product of each of which may be considered by the grader as uniform in type and may be included in one lot:

Province.	District.	Abbreviation.
Ambos Camarines	North Camarines (Daet)	N. Cam.
	South Camarines	S. Cam.
Albay	Albay	Albay.
Sorsogon	North Sorsogon	N. Sor.
	South Sorsogon (including Masbate)	S. Sor.
Samar	North Samar	N. Sam.
	South Samar	S. Sam.
Leyte	East Leyte	E. Ley.
	West Leyte	W. Ley.
Mindanao	North Mindanao	N. Min.
	South Mindanao	S. Min.

The remaining abacá-producing provinces shall each be considered a separate district by itself.

SEC. 7. Each bale of fiber of the commercial grades for cordage purposes shall bear a tag of white, unstarched, cotton cloth not less than 75 centimeters long nor less than 10 centimeters wide. One end of this tag shall be placed at or near

the middle of the bale, while the other end shall project about 12 centimeters beyond the end of the bale and shall be clearly visible. (See fig. 1.) The end of the tag inside the bale shall be knotted and just below the knot shall bear the full or abbreviated name of the grading establishment, the number of the lot, and the full or abbreviated name of the province or district of production. (See fig. 2, *a, b, c.*) The end projecting beyond the bale shall be divided into two sections, and the section adjacent to the bale shall bear the same data as are stamped on the end inside the bale, while the outer section shall bear the letter designation of the grade, the corresponding registered house mark; and, below this, the Government stamp giving the official name of the grade in full. (See fig. 2, *a′, b′, c′, d, e, f.*)

The letters and numerals stamped on this cloth tag shall not be less than 1 centimeter in height.

Each bale of abacá (manila hemp) of the grades extra prime to midway, inclusive, the fiber of which is specially cleaned and prepared for tagal braid or other similar fabrics, shall bear two tags, one of tin, and one of russet 6-ounce strap leather, each 12 by 6 centimeters, connected by a piece of wire 50 centimeters long. The end of the wire which passes through the leather tag shall be tightly twisted around the main wire for a distance of at least 10 centimeters from the end of the leather.

(*a*) The tin tag shall have the following data clearly impressed or stamped thereon in letters or numerals not less than 1 centimeter in

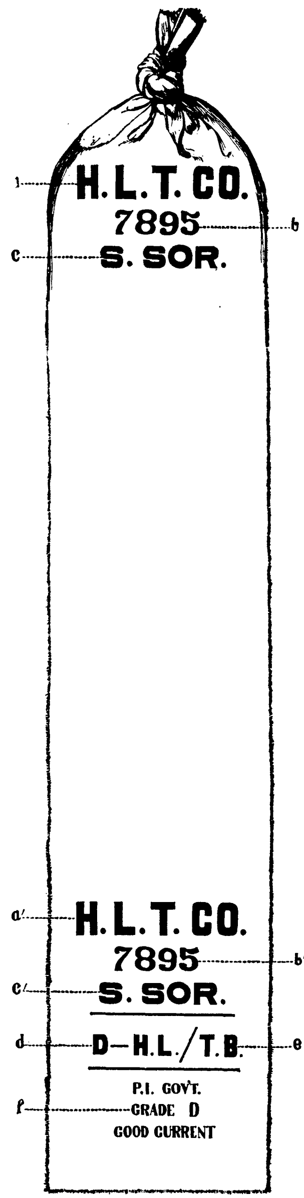

FIG. 2. Cloth tag, showing (*a, a′*) abbreviated name of grading establishment; (*b, b′*) number of lot; (*c, c′*) abbreviated name of district of production; (*d*) letter designation of the grade; (*e*) house mark; (*f*) Government stamp indicating name of standard grade.

height: (1) The abbreviated name of the grading establishment; (2) the number of the lot; and (3) the abbreviated name of the province or district of production.

(*b*) The leather tag shall have impressed or stamped on one side thereof the same data, in the same size of letters or numerals, as appear on the tin tag. In the upper part of the other side of the leather tag shall be clearly impressed or stamped, the letter designation of the grade and the house mark (if any) for that grade, the lower part being reserved for the Government inspector's stamp which shall show the standard name of the grade.

When the bale in the pressing box is halfway prepared for pressing the tin tag shall be placed at or near the middle of the bale, the wire extending to the middle of the end of the bale in such a way that the leather tag shall project beyond the end of the bale and shall be clearly visible. Only the loop of the wire which passes through the hole in the leather tag shall project beyond the end of the completed bale, the twisted part of the wire being entirely covered by the fiber.

On the mat covering the upper surface of the bale shall be stamped or stenciled in clear indelible ink the same house mark which appears on the cloth or leather tag. The official letter designation of the grade shall also be stamped or stenciled near the house mark and at a sufficient distance so as not to be confused with the letters of the house mark. (See fig. 1.) In the case of establishments which do not use a housemark, the press mark shall appear on the mat, accompanied by the official letter designation, the two forming one mark.

H. T. EDWARDS,
Director of Agriculture.

Approved:
H. S. MARTIN, *Secretary of Public Instruction.*

ONE YEAR OF THE FIBER-GRADING LAW.

By M. M. SALEEBY, *Chief, Fiber Division.*

The Fiber Grading Law [1] has been in operation one year, and it may be of interest to know what effect it has had on the fiber industry in general. Obviously, this law was intended to provide certain necessary reforms in some of the methods followed in the fiber industry, methods which were considered prejudicial to its development and welfare. It is therefore the object of this paper to discuss, somewhat concisely, the benefits obtained thus far from the law in question. This discussion will, directly or indirectly, be in the form of an answer to each of the three main questions involved: (1) What were the defects in the methods used prior to the enactment of the fiber-grading law; (2) does the law in question provide adequate remedies for such defects; and (3) if so, to what extent has the subsequent enforcement of the law remedied these defects.

The defects in the methods employed prior to the enactment and enforcement of the fiber-grading law, were directly traceable to the following causes: (1) The lack of fixed and accepted standard grades; (2) the inadequacy of the prevailing methods of grading the fiber and of designating the grades; (3) the lack of any authoritative control over the operation of the grading establishments; and (4) the more or less general ignorance of the producers as to the quality of their product.

To remedy the above state of affairs the fiber-grading law and the regulations authorized by it embody the following provisions: (1) The establishment of fixed standard grades for each of the chief commercial fibers exported from the Philippine Islands; (2) the requirement that every grading establishment shall grade and prepare fiber for export in accordance with the established standard and with the regulations; (3) the institution of a system of inspection of all graded fiber, and supervision over all grading and baling operations to enforce compliance

[1] Act No. 2380 of the Philippine Legislature entitled "An Act providing for the inspection, grading, and baling of abacá (manila hemp), maguey (cantala), sisal, and other fibers."

with the regulations; and (4) the institution of an educational campaign among the producers for the purpose of improving the methods of production and preliminary preparation of the fiber.

No fair-minded and unprejudiced person who was acquainted with the actual status of the industry prior to the enforcement of the fiber-grading law will entertain the least doubt that the defects as described above existed, and that these defects not only considerably hampered the progress of the industry, but actually prejudiced its future welfare. Also, no one, after carefully perusing the law and the regulations instituted by the Government, can possibly doubt that its motive, in promulgating and enforcing these rules and regulations, is the restoration of the industry to its former state of prosperity. Indeed no just criticism can be directed against the Government by a well-informed person, except perhaps with regard to the failure to adopt these same measures at an earlier period, when conditions had not become so bad as at the time the present measures went into effect, and when the solution of the problem could have been more easily accomplished and much more harm avoided.

Obviously then, the main issue resolves itself into the question as to whether or not the admittedly beneficial measures prescribed in the law and regulations have been effectively applied and enforced, and the desired reforms obtained. This brings us to the subject proper of this paper, which will be discussed under the various phases which it involves. These are, standardization of grades, proper grading, and proper preparation of fiber.

STANDARDIZATION OF GRADES.

The establishment of systems of standards has recently been a very important factor in the development of industry and commerce. Standards of measures have been used from time immemorial, but it was only in comparatively recent times that such standards have been extended to include the quality of almost innumerable commodities and products. Industrial and commercial products, both in the raw and manufactured forms, are now being standardized to such an extent that this system of standardization is bound to figure prominently among the most notable achievements of the age. By standardization, mistakes and misunderstandings are avoided, defects are discovered and remedied, and commercial and industrial expansion is greatly facilitated, especially between distant countries. Indeed it is difficult to overestimate the advantages accruing from the use of adequate and fixed standards.

The use of standards for designating the quality of commodities is just as essential as the use of standards for measuring their weight and dimensions, particularly in those instances in which the value of commodities depends in a large measure on their quality. A beginning only has been made in the establishment and use of fixed standards of quality in connection with some agricultural products, but strong tendencies to extend them are gradually becoming more apparent. The day is not far off when transactions in most agricultural products of international importance will be carried out on the basis of accepted standards of quality.

In the case of commercial Philippine fibers, especially abacá (manila hemp), it may be safely stated that no fixed and generally accepted standards of quality existed prior to the enactment of the fiber-grading law. Abacá varies considerably in quality and in value, and the old methods employed in designating its quality, either in local or foreign transactions, could hardly be called standards in the true sense of the word. The fiber was purchased, graded, and sold almost exclusively under house marks. In theory each house mark represented a specific grade, but in practice such was not the case. Even granting that these house marks did represent specific grades, there were in existence from 80 to 90 grading establishments, each of which used from 10 to 40 or more separate house marks, aggregating a total of approximately 2,500 to 3,000 marks. Other than a house mark there was nothing on the bale to designate the quality of the fiber it contained. Obviously, such a method was too complicated and too indefinite to be worthy of the name of a standard. The fiber producers, of course, had absolutely no knowledge of what these marks represented, and the manufacturers were forced to know and keep a record of several hundred marks in order to be able to purchase fiber intelligently. Arbitrations were frequently required in order to interpret the correct grade as represented by a certain house mark. If to this is added the inconstancy and unreliability of a large number of the marks then existing, an idea may be gained of the unnecessary friction and confusion which often occurred in these business transactions.

The provisions of the fiber-grading law and the subsequent regulations authorized by it were adequately enforced during the year. Standards of quality were designated and defined, and every bale exported from the Philippine Islands since the date on which the law and regulations went into effect, bears the name of the grade of the fiber contained therein, the name

of the grader, the name of the district or province where the fiber was produced, and other marks and data of identification.[1] It is true that house marks are still being used, but their use has become limited to a small number of grading establishments. In such cases the marks are secondary in importance and their use is allowed only when they constantly refer to the corresponding grades of the official standard. In other words, buyers are now obliged to know only the few grades of the official standard, and they can order the grade required by them with every reasonable assurance that when they receive the fiber every bale will invariably bear the name of the grade ordered and contain fiber of the quality desired. With equal assurance they are also enabled to obtain any type of the fiber for which they may have a preference. The producers, on the other hand, are now offered for the first time the oportunity of learning the exact, or at least the approximate, quality and value of their product. This should be of considerable value to all producers who may avail themselves of the opportunity.

PROPER GRADING OF FIBER.

The grading of fiber is based chiefly on its apparent qualities. Variations in quality are either natural or else caused by the manner of extraction and the subsequent handling. The extent of variation allowed between one grade and another is determined by the character of the fiber and the nature of the uses thereof. As a rule, in textile fibers from which fine fabrics are made, the grading is closer and the range of variation in quality is rather small. In cordage fibers, however, such a fine distinction is not called for, and the range in quality is consequently much larger. To grade cordage fibers as closely and as minutely as silk or cotton, for instance, would not only entail an expense and trouble out of proportion to the value of the fiber, but would be considered by the manufacturers an unwarranted waste of energy and time, and for which they would not be willing to pay the proportionately higher prices. The grading of cordage fiber is, therefore, generally considered to be an easy process. This is true of most fibers of this class, such as sisal, maguey, hemp,[2] tenax,[3] and others in which differences in quality are caused chiefly by the method and the extent of cleaning. The grades of such fibers are limited, however, rarely exceeding four in number. In the case of abacá the grading

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[1] See General Order No. 47, appearing in this issue of THE REVIEW.

[2] The true hemp, such as "Kentucky hemp," "Italian hemp," etc.

[3] New Zealand hemp.

Government fiber inspectors inspecting sample bales of a lot of abacá (manila hemp) and describing the character of the fiber in each grade.

Government fiber inspector inspecting a lot of fiber at a grading establishment by sample bales of all the grades included in the lot.

is more difficult, perhaps more so than in any other cordage fiber, not because of any finer distinction between the grades but because of the greater variation in the quality. The formation of the abacá stalk is in itself responsible for four distinct grades, to which must be added other grades caused by variations in the extent of cleaning and in the handling of the fiber prior to its arrival at the grading establishment. Natural variations affect the color and length of abacá, but not necessarily its character, while variations caused by improper cleaning and handling affect both color and character.

To grade fiber properly the standard followed must embrace a number of grades sufficient to provide for any variation in color and cleaning which may be encountered in the marketable product. The number of grades in the standard, therefore, depends upon the extent of variation which is considered sufficient to constitute a grade. It is believed that the grades as established in Bureau of Agriculture General Order No. 47, and as described elsewhere in this number of THE REVIEW, are sufficient to include with a reasonable allowance for variation in color and cleaning, any of the fiber coming under the standard, and in any condition in which it may be in. Such variations as may be encountered in any one grade are not considered incompatible with the uses made of the fiber therein. The name of the district where the fiber is produced in most cases designates the degree of variation, and in this sense may serve as a subgrade or type.

In this connection, critics of the system insist that it is not the Government's duty to determine the number of grades of the standard, but that the manufacturers of the fiber should do so. To this it may be said that the Government consulted the principal manufacturers and buyers, and that the standard as now established has the approval of the majority of the firms. As a matter of fact, the few criticisms directed against the present system are based on directly conflicting arguments, one faction claiming that the insufficiency in the number of grades of the standard jeopardizes the efficiency of the system, while the other faction claims that the same efficiency has been affected by the establishment of too many grades. The majority of those who are of the latter opinion, it may be stated, are brokers and not the actual users of the fiber.

Under the old method of grading abacá fiber, there existed at least ten grades more than are now recognized under the Government standard, and the tendency was to still further increase them by a process of sub-division. This sub-division of

the grades had progressed so far that the original basic grades had become almost mere vague and imaginary standards. When a fiber was a trace higher or lower in color or cleaning than a certain grade, it was graded as $12\frac{1}{2}$ or 25 per cent above or below the grade. To find a fiber exactly of the required narrow limits of color, cleaning, and condition, to which the basic grades were reduced, therefore, became extremely difficult. Had the grading of fiber been uniform both in the bale and in the several bales constituting the lot, it might not have been so bad, but the grading of the majority of the establishments was not regular nor uniform, hence unjustifiable mixtures were often encountered, and these became the prevalent basis for the determination of the intermediate grades. This procedure was obviously inadequate and unwarranted, and the large number of grades which were constantly appearing on the market afforded opportunities for so much speculation and arbitration that the smoothness and regularity of transactions, which are essential to all kinds of business, were seriously disturbed.

By the operation of the new system of fiber grading the old tendency to create intermediate grades has been effectively checked, and the fixed grades of the new standard have replaced the old ones. No attempt at grading to intermediate grades is allowed, and in fact this method has really become difficult of accomplishment without actually mixing fiber of two distinct grades, thus causing it to be rejected by the Government fiber inspector. The cost to the grader of this rejection often exceeds whatever advantages he may have expected to obtain from the sub-division of the grade. The fiber inspectors have also accomplished good results during the year by supervising the grading at the press, bringing the gradings of the various establishments into closer uniformity, and also eliminating, or at least reducing to a minimum, the mixing of damaged or otherwise undesirable fiber with that of normal strength and condition. This is particularly true in the case of the less capable establishments in the provinces. That this work has not been perfected does not in the least discredit the system in general or reflect on the efficiency of the organization. It is a large and a difficult enterprise, the perfection of which requires both time and experience.

PROPER PREPARATION OF FIBER.

The difficulties encountered in the proper grading of abacá are not due to the natural variation in its quality, but to those variations caused by improper cleaning and handling. A lot

of fiber which is properly cleaned and sorted at the knife, and subsequently carefully dried and handled, is not any more difficult to grade than either sisal or maguey, nor will it be found to contain more than four or five grades which are easily distinguished and sorted out. Such fiber, as a rule, is produced by progressive and intelligent men who manage their plantations by up-to-date methods, maintain the necessary supervision over the labor, and sell their fiber by grade directly to exporters or large buyers. These planters invariably find it to their interest to sort their product so as to facilitate its grading. Unfortunately, however, the bulk of fiber producers in the Philippine Islands do not belong to this class. They are either small land owners who produce fiber with their own limited means, or else owners of large plantations who leave the entire management to employees of little or no responsibility. As a result, a very large quantity of fiber is produced which is neither cleaned in a uniform manner, sorted, nor properly dried and packed. The grading of such fiber is often a very trying process, and in spite of any reasonable attempts to sort and clean the fiber, it never presents the clean and orderly appearance of well-prepared fiber of similar grades. Apparently, such producers are directly to blame for the production of fiber in this condition; in reality, however, the local town buyers should have a large portion of the blame. They make no discrimination, in the matter of prices, between well or poorly prepared fiber, thus discouraging the production of the better grades.

At the outset it was realized by the fiber division that an improvement in the above situation was necessary if the new system was to be perfected. As soon as circumstances permitted a force of assistant fiber inspectors was organized, trained, and detailed to the principal fiber-producing provinces, for the purpose of educating the producers in the proper methods of cleaning and handling their fiber. The lack of proper machinery for the uniform cleaning of abacá considerably hampered the success of this work, but the attempt proved justifiable and it was continued. This work was supplemented by the publication and distribution of weekly market quotations for the different grades of abacá and maguey, of literature regarding some necessary improvements in methods of cultivation, and by the distribution of samples of the standard grades to the producers. The success of this campaign was more pronounced and rapid in the maguey-producing provinces, especially in Northern Luzon, and there the quality of the fiber now produced is considered fully equal to that of the Cebú product.

In abacá provinces, the campaign met with considerable success in some districts but with little in others. The net results, however, were so valuable that the same work will be continued indefinitely.

It is the opinion of the writer that this work will have to be given increasing attention by the Government, with a view of studying the economic status of the producers and of providing such means as will make them independent of the local town buyers. This, more than anything else, will assist in remedying the economic situation of a large class of producers and will facilitate the work of this division in bringing about the desired improvement in the preparation of fiber for the export trade.

DESCRIPTION OF THE STANDARD GRADES OF PHILIPPINE FIBERS.

By M. M. SALEEBY, *Chief, Fiber Division.*

The number and designation of the official standard grades of the chief commercial fibers of the Philippine Islands are given in Article I of Bureau of Agriculture General Order No. 47, which is printed in this issue of THE REVIEW. In Article II of the same order are explained the principal characteristics which, in each of the fibers included in the regulations, determine the grade and its type, but no attempt is made to give a specific description of each grade. It is the object of this paper to give such a description and it is intended that this description shall be based on the apparent qualities of the fiber in each grade, and the variations which may be encountered in the character of the fiber in the different districts where it is produced.

Such a description is difficult in the case of abacá, perhaps more so than of any other hard fiber, and it is presupposed that the reader has a practical knowledge of the commercial grades of this fiber before he can thoroughly understand this description. It is true that an accurate understanding of the grades of abacá can be obtained only by continued examination and handling of the fiber on a more or less large scale. The same thing is true in the case of almost all other fibers although abacá presents a particular difficulty owing to the variable methods used in its preparation and preliminary handling. In spite of all these difficulties, it is believed that a specific description of the grades as is proposed in this article, although it may be practically unintelligible to the layman, may prove of considerable help to all persons who have had experience with Philippine fibers.

For the purposes of this article the standard grades of abacá are classed under four groups, according to the extent of their cleaning, or fiber extraction. The grades of each group will be described separately, beginning with the lowest grade, thus showing as clearly as possible the gradation which exists in their apparent characteristics.

STANDARD GRADES OF ABACÁ (MANILA HEMP.)

GROUP 1.—*Those of excellent cleaning.*

The grades included in this group are "Extra prime" to "Streaky No. 3," excluding "Current," which is oftener of good

than of excellent cleaning. In these grades the cleaning is perfect, or nearly so, and the product is practically pure fiber, hence the texture is generally soft (except in the product of South and North Mindanao which is sometimes medium in texture) and the tensile strength is at its highest average. During 1915, 288,159 bales of abacá of this group were produced, which represent 28.4 per cent of the total production for the year. While the grades of this group are to a greater or less extent produced in every province, they form the bulk of production only in Cavite, Mindoro, South Mindanao (Davao Province), Samar, West Leyte, Tayabas (Marinduque), and Panay (Capiz and Iloilo).

Streaky No. 3.—This grade is produced entirely from the outside sheaths of certain varieties of the abacá plant, the color of which is naturally dark. For this reason the predominant *color* of the fiber is a light purple, with but few streaks of dingy white fiber running through it. The color of the fiber from the middle towards the tip is usually darker than the rest. In this grade the fiber is invariably short, rarely exceeding 1.25 meters (4 feet) in *length.*

Streaky No. 2.—This grade is produced from sheaths next to those on the outside of the abacá stalk of the same varieties from which "Streaky No. 3" is produced, or from the outside sheaths of other varieties in which the stalks are naturally of a lighter color. The *color* of this fiber is a mixture, in more or less equal proportion, of dingy white and red, or light purple. The fiber is almost invariably short, rarely if ever exceeding 1.5 meters (5 feet) in *length.*

Streaky No. 1.—This grade is also produced from the few sheaths next to those on the outside of the abacá stalk. These sheaths are slightly longer and less colored than the outer ones, hence the predominant *color* of the fiber is a light ivory-yellow or light ochre, mixed with a few streaks of a light reddish color. The *length* of the fiber is usually short although fiber of normal length is sometimes encountered.

Midway.—This grade is as a rule obtained from the middle sheaths of the abacá stalk which are of a light ochre color and extend the whole length of the stalk. Purple or red colors in any noticeable quantities are absent in this grade, and the length of the fiber is entirely governed by the extent of growth of the plant. In the typical grade the characteristic *color* of the fiber may be described as ochre, often interspersed with traces of a light ivory-yellow color which really belongs to the next higher grade. The proportion of Midway fiber in the abacá stalk, when

the fiber is cleaned and dried carefully, does not exceed 10 to 15 per cent. This proves that the bulk of the production of this grade in such provinces as Samar, Leyte, and North Mindanao cannot be entirely typical. A large proportion of Midway fiber as it is generally encountered in the market is nothing more than a Good Current fiber which has depreciated in color on account of improper drying and handling. Such Midway fiber may be distinguished from that of the typical grade by the lack of the luster which the latter often exhibits.

Midway fiber is not infrequently encountered in which the cleaning cannot be called strictly excellent, it being slightly strippy and more in the nature of "Current" fiber. In such cases, however, the strips are usually soft and fine, with a high color almost approaching that of Good Current. Sorsogon and Albay "Midway" are often of this nature.

In point of production, this grade ranked fifth among the entire grades of abacá during the year 1915, when 115,600 bales, or 11.4 per cent, were produced. Of this amount Leyte produced 38,747, Samar 25,803, North Mindanao 20,451, and Sorsogon 10,803 bales.

Good current.—The predominant color of the fiber in this grade is a very light ochre, interspersed with considerable quantities of a light ivory-yellow fiber. The *length* of fiber is normal or long, depending entirely on the extent of growth of the plant. The texture is generally soft, except in the case of the varieties of the plant which produce a fiber naturally of a hard or medium texture.

This grade is the lowest of the so-called superior grades, and the production of this has, during the last seven or eight years, generally failed to meet the demand for it. During 1915, only 57,161 bales of this grade were produced out of a total annual production of 1,011,366 bales, or 5.6 per cent. It will be well for the industry if the production of this grade can be increased at the expense of some of the low, strippy grades. It may be safely stated that in those provinces where more or less up-to-date methods are being used by the progressive element of producers, the average production is rarely under "Good current" and in some cases it is even higher.

Superior current.—The *color* of fiber in this grade is a light ivory-yellow, a considerable portion of which usually approaches white. In *length, texture,* and *cleaning,* the fiber is essentially the same as in Good current, perhaps slightly softer and better cleaned in some instances.

This grade, although the third in regard to quality, can safely

be called the highest for cordage purposes, the "Prime" and "Extra prime" grades being used only on a very small scale for this purpose. The production of this grade is also, unfortunately, much below what it should be, amounting during 1915 to only 34,323 bales, or 3.4 per cent of the total production for the year. Even this quantity is not all available for cordage as quite a large proportion of it is used in Japan for the manufacture of hat braid, commonly known as "tagal."

Prime and extra prime.—These grades constitute the second and first, respectively, of the superior grades. They are described together because their characteristics are very much the same in respect to *texture, cleaning,* and *length* of fiber. The *color* of the fiber in both grades is practically white, although it is a little more so in "Extra prime." These two grades are obtained from the interior sheaths around the core of the abacá stalk. These sheaths are naturally whiter, softer, and a little shorter than those immediately surrounding them. For this reason the texture is always soft, irrespective of the variety of plant or district of production.

The best fiber of these grades comes from the Provinces of Cavite, Davao, and Camarines. In fact, these provinces produce the bulk of this fiber. The production of "Extra prime" and "Prime" during 1915 amounted to 27,493 bales, of which Cavite produced 9,380 bales, Davao about 3,117 bales, and Camarines 6,749 bales. By far the larger proportion of these two grades is being exported to Japan for the manufacture of tagal braid, for which very much higher prices are paid than can possibly be paid by the cordage trade.

GROUP 2.—*Those of good cleaning.*

The grades included in this group are "Current," "Seconds," and "Brown." The grade "Good fair" as produced in Samar, West Leyte, and a few other provinces or districts producing the so-called soft grades comes under this group, but the grade in general belongs to the next group, in which it will be included.

In these grades the cleaning is not perfect and the product is usually in the form of very fine soft strips, or a mixture of pure fiber and fine, soft strips, which for all practical purposes may be considered fiber, the latter form being perhaps more prevalent. For this reason the cleaning is generally described as "good," and the texture as "medium." During 1915, 213,623 bales of this group of grades were produced, or 21.2 per cent of the total production for the year. The bulk of these grades comes

from Leyte, Samar, Sorsogon, and North Mindanao, Leyte leading with about 45 per cent of the total production.

Brown.—This is the lowest grade in this group. Its *color* is usually dark brown or brown, more so towards the tips of the fiber, due to the fact that the tips of the outside sheaths of the abacá stalk from which it is produced are thin and are usually in a more or less dried condition thus rendering the separation of the pulp difficult. The grade "Brown" as produced in East Leyte is usually of a darker color than in most other provinces, due to the prevalence there of varieties of the plant having dark-colored stalks. The *texture* of the fiber is usually medium and its *length* short.

This grade is sometimes encountered in fiber originally of a higher grade, but which, owing to subsequent neglect in proper handling and drying, has become dark. Such fiber usually has a greater length than that of the typical grade. This grade corresponds to "Streaky No. 3" of the grades of excellent cleaning, the difference between them being in the extent of cleaning, which accounts for the darker color and comparatively harder texture of the grade "Brown."

Seconds.—This grade is produced from the same sheaths of the abacá stalk from which "Streaky No. 2" is produced, the difference between the two grades being in the extent of cleaning, the same as that between "Brown" and "Streaky No. 3." The *color* of fiber in the grade "Seconds" is therefore a mixture, usually light green with light brown, the tips being generally darker than the rest, similar to the Streaky and "Brown" grades. The *length* of the fiber in the typical grade is oftener short than normal.

It is not always the natural color of the stalk which is responsible for the peculiar mixed color of this and the "brown" and "streaky" grades, but any considerable injuries to the stalk, such as bruises, or partial decay caused by felling or delay in cleaning of the fiber, produce the same or a similar effect. In the latter case, however, the color is more of a light yellow or red than light brown or green.

This grade also may be encountered in fiber originally of a higher grade, but which, owing to improper cleaning and drying, becomes a little too dark for that grade. The color of such fiber differs from the typical color described above, being dingy red or light brown throughout.

Current.—The *color* characteristic of this grade is as hard to describe as those of the grades "Midway" to "Extra prime." It

is a shade of very light brown, and is caused by the action of the acid when this is allowed to remain on the fiber for any length of time. This often happens when the fiber is either not thoroughly cleaned or when it is not dried promptly after its separation from the pulp. The *texture* of the fiber is medium, except in those cases in which a "Midway" fiber has so deteriorated in color as to render necessary its grading as "Current." Such fiber will be described as being of soft texture and excellent cleaning,[1] and is usually produced in Samar, Leyte, and in some unimportant districts, such as Mindoro, Marinduque, Cebú and others, where the superior grades form the bulk of production. The *length* of the fiber is normal or long, the latter being produced chiefly in some of the North and South Mindanao provinces.

This grade is unquestionably the most important of all the grades of abacá which are of good or excellent cleaning. Its importance does not consist in any superior quality of its fiber, but in the extent of its supply and the demand for it. During 1915, there were 148,650 bales of this grade produced, of which 61,497 bales came from Leyte, 24,705 bales from Samar, 20,013 bales from Sorsogon, 19,668 bales from North Mindanao, and 11,149 from Albay.

GROUP 3.—*Those of fair cleaning.*

The grades included in this group are "Good fair," "Fair," and "Medium." In these grades the cleaning is generally described as fair, and the texture hard, the product being either pure strips or slightly mixed with fiber proper. The strips are usually 1 to 1½ millimeters in width. The two lower grades of this group are the highest grades of the so-called U. K. (United Kingdom) fiber, for the reason that nearly all of this fiber produced is purchased by British cordage manufacturers. During 1915, there were produced 297,212 bales of the three grades of this group, or 29.4 per cent of the total production for the year. The bulk of these grades is produced in the Provinces of Leyte, Albay, and Sorsogon. The first two provinces are credited with over 98,000 bales each, and the last with over 60,000 bales.

Medium.—The *color* of fiber in this grade ranges from light to dark brown, or, in other words, it comprises the low seconds, and brown colors. The *length* of fiber is usually short in the typical grade, and normal in fiber originally prepared as "Fair" and subsequently reduced to this grade on account of improper drying and handling.

[1] This is the grade 37½ over current of the old standard.

Fair.—This grade is the highest among the so-called U. K. grades, corresponding, as a rule, to the grade "Fair Current U. K." of the old standard. In *color* it ranges from that of high seconds to current, and in length it is almost invariably normal, being rarely long or short. When of the color of high seconds, and comparatively soft in texture, this grade is more or less equivalent to "Superior Seconds U. S." of the old standard. The typical grade coming from Albay or Camarines, which is of hard texture and good color, is more in demand for the European trade.

During 1915, there were produced 140,321 bales of this grade, of which Albay (chiefly the Legaspi district) is credited with 61,974 bales, Leyte (chiefly the eastern part) with 38,485, and Sorsogon with 25,868 bales. In point of production, therefore, this grade ranks second only to "Current".

Good fair.—Owing to the variable method of cleaning abacá fiber in the several provinces, a large quantity of fiber is produced which is considered too good for "Fair" and too low for "Current." Its color, cleaning, and texture are also such as would render undesirable its inclusion in "Seconds." For these reasons it was considered necessary to establish a separate grade for this fiber.

Typical "Good fair" fiber is of fair *cleaning,* hard *texture,* and current *color,* and is generally produced in Albay, Sorsogon, and Camarines. Such "Good fair" fiber as comes from Samar, Leyte, and other provinces, which produce superior grades mostly, is, as a rule, of good cleaning and medium texture, the same as "Current," but too low and dingy in color to be placed in the latter grade. The *length* of fiber is generally normal, as in the grades "Current" and "Fair."

During 1915, there were produced 110,132 bales of this grade, giving it fourth rank among all the grades in so far as production is concerned. The greater portion of the supply of this grade comes from Leyte, Sorsogon, Albay, and North Mindanao, which produced in the above-mentioned year 50,096, 29,863, 12,610, and 9,774 bales, respectively.

GROUP 4.—*Those of coarse cleaning.*

The grades included in this group are "Coarse," "Coarse brown," "Daet Coarse," and "Daet coarse brown." The fiber in the two latter grades is more in the nature of straw material than actual fiber, hence their description will be given after that of the first two grades of the regular standard. The fiber in the grades of this group is in the form of pure strips and may be

described as hard in *texture* and of coarse *cleaning,* with some variation of degree in the several districts of its production. The production of the Daet type of fiber is unfortunate in the extreme, and judging from experience during the first year of the operation of the fiber law it is possible that it will be gradually eliminated from the market at no distant date.

During 1915, there were produced 197,018 bales of all the grades of this group, including the Daet grades. These figures represent 19.5 per cent of the total production for the year. During 1916 the Daet grades will be listed separately and it is regretted that this was not done in 1915. Albay, particularly the Tabaco district, and Camarines produced the bulk of the grades of this group, with a total of 159,231 bales, of which the former produced 96,989 and the latter 62,242 bales.

Coarse brown.—Strictly speaking, this is the lowest of the grades proper. In *color* it is the same as that of "Medium," ranging from that of low seconds to brown; in *texture,* it is always hard, although comparatively softer in some provinces or districts than in others; and in *cleaning,* it is always coarse, the strips being distinctly wider and, as a rule, thicker than those of the grade "Medium." The *length* of fiber is either short or normal, not infrequently mixed.

Coarse.—This is the highest grade of this group. Its color is similar to that of "Fair," ranging from that of high Seconds to Current. In *texture* and *cleaning* it is identical with the preceding grade.

Practically the entire supply of Coarse and Coarse Brown is exported to Great Britain and other European countries, where they are the most popular grades, not for any superior quality, but for economic reasons. The best type of these grades is produced in Legaspi (Albay) and Lagonoy (South Camarines).

Daet grades.—In *color* and *length* of fiber the "Daet coarse" and "Daet coarse brown" are indentical with "Coarse" and "Coarse brown," respectively. The cleaning of the fiber in the former grades, however, is so poor and the strips are so wide and thick that it is with only a stretch of the imagination that they can be considered as fiber. For this reason these have been designated in General Order No. 47 under the standard for woody fibers. This type of fiber is produced mainly in Camarines, the Tabaco and Virac districts of Albay, and a little is produced in the districts of North Mindanao.

It is very doubtful whether the Daet grades can be used to advantage for cordage purposes, except perhaps as a mixture with the higher grades. There can be no doubt that the production

of this type of fiber has hurt the reputation of our abacá, and for this and local economic reasons its production should be discouraged. During March and April of last year (1915) a worse type of strippy product appeared on the local market, coming from the Buhi district of South Camarines, and the writer immediately instructed all fiber inspectors in Southern Luzon not to grade it under any standard, even under the "Daet type." This prompt action resulted in its disappearance from the market in less than two months after its first detection.

STANDARD GRADES OF MAGUEY AND SISAL.

GROUP 1.—*Retted fiber.*

There are three grades of maguey and sisal in this group, which includes all fiber that is cleaned by retting the leaves in water. Such fiber is distinguished by its softness, lack of luster, a marked deficiency in its tensile strength, and in most cases by the presence upon it of gummy scales. These scales are caused by the leaves bruising one another with their terminal spines when swayed by the wind. It is often hard to distinguish between retted maguey and retted sisal as the retting process destroys the original color and texture, which are the only distinguishing characteristics.

Maguey or sisal No. 3.—In this grade the retting process is usually carried to excess thus causing considerable discoloration and deficiency in strength, especially towards the tips of the fiber. The scales are abundant in most cases. Maguey or Sisal No. 3 may therefore be decribed as being of fair *cleaning,* low *color,* and low *strength.*

In all cases in which the fiber is either overretted, causing excessive discoloration and deficiency in strength, or insufficiently retted, causing the presence of hard woody strips, the fiber is considered as damaged and is graded as such.

Maguey or sisal No. 2.—In this grade the retting process is usually done properly, the scales are scarce, and the strength normal, but the fiber is not subsequently well washed and dried, hence the color is a dingy white. This grade may, therefore, be described as being of good *cleaning,* good *color,* and normal strength.

Maguey or sisal No. 1.—The retting process, as well as the subsequent operations of washing and drying, are properly and carefully carried out in all fiber of this grade, with the result that the color is white, the scales absent, and the strength good. This grade is therefore usually described as being of excellent *cleaning,* high *color,* and good *strength.*

GROUP 2.—*Knife or machine cleaned fiber.*

The grades included in this group are "Maguey or sisal, Good," "Maguey or sisal, Fair;" and "Maguey or sisal, Common." The fiber in these grades is generally uniform in cleaning and tensile strength, therefore the grade is determined by the color.

Knife or machine cleaned fiber is superior to the retted fiber in strength and luster, and may be easily distinguished from the latter by its harsher texture and freedom from scales. The production of such fiber is very limited, however, and efforts are being made by the Bureau of Agriculture to encourage its production on a large scale. The small quantities of this class of fiber so far produced compare very favorably with the best grades of German East Africa and Java sisal.

Knife or machine cleaned maguey can be easily distinguished from similarly cleaned sisal. Maguey is comparatively softer, finer, and of a whiter color than sisal, the color of the latter fiber being slightly yellowish.

Mgy or Ssl, Common.—This is the lowest grade of this class of fiber, the dominant color of which is either dingy red or greenish. The former color is caused by harvesting over-mature leaves, which are usually marked by bruises or by a partial drying up; while the latter color is caused by delay in drying the fiber, or by neglecting to wash it immediately after cleaning.

Mgy. or Ssl., Fair.—In this grade the color of the fiber is generally a dingy white, due mainly to neglect in not drying the fiber immediately after cleaning. In some instances the fiber is dried before washing away the traces of green pulp left attached to it, with the result that it then exhibits a light greenish rather than a dingy white color.

Mgy. or Ssl., Good.—In this grade the fiber is white and lustrous, and is the result of perfect cleaning and prompt washing and drying. If the process of cleaning is not faulty in any way, and the washing and drying of the fiber is promptly and properly executed, all the fiber turned out should be of this grade. In other words, the color of the leaves of the normal maguey or sisal plant and the character of the fiber they contain is exactly the same in all the mature leaves, hence the color of the fiber is entirely dependent upon the manner of cleaning it and the extent of care with which it is thereafter handled. In the case of abacá, however, the variety of the plant, the structure of the stalk, and the character of the sheaths forming it, are in themselves directly responsible for at least four or five distinct grades.

STATISTICAL REPORT OF FIBER PRODUCTION IN THE PHILIPPINE ISLANDS DURING THE YEAR 1915.

By M. M. SALEEBY, *Chief, Fiber Division.*

For the first time in the history of the fiber industry of the Philippine Islands it is possible to give accurate data relative to fiber production[1] by provinces and by grades. This information will enable all those who have control over the industry to gauge its progress from time to time, and to take such steps as may be deemed advisable and practicable in order that production may be adjusted to meet the best interest of the producers, as well as the actual requirements of the consuming market. These data are also believed to be of considerable value and interest to both local and foreign buyers and manufacturers, for they are thus adequately advised of the available supply of fiber of each grade on the market.

The Government fiber inspectors, during the year 1915, inspected, stamped, and approved 1,011,366 bales of abacá (see Table A) and 59,940 bales of retted maguey (see Table C). In addition to the above, 224 bales of retted sisal and 483 bales of pacol were also inspected and approved, making a grand total of 1,071,983 bales.

During the year the fiber inspectors rejected 35,000 bales of abacá, or about 3 per cent of the total production, on account of improper grading, packing of damp fiber, or because of the presence of weak or damaged fiber. The most of these rejected bales were regraded and rebaled, however, and the balance was disposed of on the local market, on the ground that it was considered undesirable for export.

Tables A and C give in detail the number of bales of abacá and maguey inspected and approved during the year 1915, by provinces and by grades. These tables are a summary of the monthly reports which were published regularly during the year

[1] Production is here used in reference to quantities available for export. Actual production is estimated at between 3 and 5 thousand bales more than exports.

and distributed to all grading establishments in the Philippine Islands, and also to fiber buyers and manufacturers in the United States and Great Britain. (See Tables D and E.) In Table B, which is a summary of Table A, the grades are arranged in groups so as to show, in addition to the production of each grade, the production of each group of grades in which the fiber is somewhat similar in cleaning and in which the fiber is generally used for the same or for similar purposes.

Since the drought of 1912–13, the production of abacá has been below normal. During 1915 it was slightly in excess of 1914; and, until the final quarter of the year, all indications pointed to a complete recovery of the plantations from the effects of the last drought, and to a production of between 1,100,000 and 1,200,000 bales for 1916. These hopes were not realized, however, as a series of destructive typhoons passed over the provinces of Albay and Camarines between October 23, and December 10, injuring the plantations there to the extent of an estimated shortage of about 75,000 bales. The last typhoon, of December 6, damaged Sorsogon Province rather severely, and as a result of this, the production for this province during 1916 is estimated to be about 10 to 12 per cent less than during 1915, or a loss of about 12,000 to 15,000 bales. This makes an estimated total loss for the three Southern Luzon provinces during 1916 of about 90,000 bales.

Fortunately, Leyte, Samar, and Mindanao have escaped any damage from typhoons during the year and the plantations there have continued to recover from the effects of the drought of three years ago. In these provinces an increase of production during 1916 is therefore expected, and it is hoped that this gain will nearly offset the estimated loss in the three provinces of southern Luzon. To these bright prospects must be added the extraordinarily high prices paid for fiber since the latter part of 1915, which will undoubtedly induce the producers all over the Islands to harvest the maximum quantity of fiber which their plantations are capable of producing. In many cases, this tendency is unfortunately too marked, with the result that the plants are often injured by excessive harvesting.

Taking all the above factors into consideration, it is believed that production during 1916 will be about the same as that of the previous year. During the first six months of 1916, production is expected to be considerably lower than it would be under normal conditions, but during the latter half of the year it is hoped that it will rapidly increase as the damage caused by a typhoon rarely lasts longer than seven to nine months.

Sample bales of abacá (manila hemp) awaiting inspection at the central fiber-inspection office, Manila. Each one represents samples of the different grades included in one lot.

Grading abacá at one of the chief grading establishments in Manila.

Sorting abacá fiber, tying in hands of proper size, and cutting off dirty tips previous to grading.

U. of MICH.

TABLE A.—*Total production of abacá (manila hemp) by provinces and grades during the year 1915.*

District of production.	Standard grades.								
	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
Albay	847	1,917	5,596	6,286	4,466	358	165	116	11,149
Leyte	3	124	651	7,098	38,747	8,129	9,619	4,372	61,497
Camarines	1,943	4,806	7,530	5,693	2,302	777	448	60	1,454
Sorsogon	79	1,923	4,155	5,704	10,223	721	883	191	20,013
Samar	21	493	3,116	12,779	25,803	6,096	8,528	2,678	24,705
North Mindanao		34	621	5,841	20,451	2,057	2,551	1,215	19,668
South Mindanao	827	2,290	4,938	5,659	6,616	1,673	494	163	7,383
Cavite	5,165	4,215	1,576	109	27	27	1		
Mindoro	7	565	3,398	2,974	876	22	46	10	325
Tayabas		286	1,063	1,393	842	15	6		282
Cebu		17	143	1,447	3,183	1,227	309	123	977
Various	786	1,145	1,542	2,178	2,064	233	221	48	1,197
Total	9,678	17,815	34,323	57,161	115,600	21,335	23,271	8,976	148,650
Percentage	1	1.7	3.4	5.6	11.4	2.1	2.3	0.9	14.7

District of production.	Standard grades.								Total.
	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
Albay	1,803	2,008	12,610	61,974	23,654	70,976	26,013	3,154	233,086
Leyte	18,912	13,664	50,096	38,485	9,830	1,302	277	4,341	267,147
Camarines	628	261	1,865	7,022	3,029	40,636	21,606	1,159	101,219
Sorsogon	7,908	6,805	29,863	25,868	4,569	2,193	386	1,890	123,374
Samar	5,518	747	3,216	415	87	194	95	751	95,242
North Mindanao	3,514	1,102	9,774	5,534	4,178	5,396	9,171	1,833	92,940
South Mindanao	1,065	105	2,210	213	1	53	39	591	34,320
Cavite								246	11,366
Mindoro	46		16	18		2		7	8,312
Tayabas	51		11	88	4	4,608	833	4	9,486
Cebu	261	161	221	147	285	209	450	611	9,771
Various	303	111	250	557	1,122	5,857	6,722	737	25,073
Total	40,009	24,964	110,132	140,321	46,759	131,426	65,592	15,324	1,011,336
Percentage	4	2.5	10.9	13.9	4.6	13	6.5	1.5	100

TABLE B.—*Summary of production of abacá (manila hemp) according to grade and cleaning during the year 1915.*

Grades.	Bales.	Percentage.	Cleaning of fiber.
Extra prime	9,678	1.0	Excellent.
Prime	17,815	1.7	
	27,493	2.7	
Superior current	34,323	3.4	Do.
Good current	57,161	5.6	
	91,484	9.0	
Midway	115,600	11.4	Excellent.
Current	148,650	14.7	Good.
	264,250	26.1	
Good fair	110,132	10.9	Fair.
Fair	140,321	13.9	
	250,453	24.8	
Streaky No. 1	21,335	2.1	Excellent.
Streaky No. 2	23,271	2.3	
Streaky No. 3	8,976	0.9	
	53,582	5.3	
Seconds	40,009	4.0	Good.
Brown	24,964	2.5	Do.
Medium	46,759	4.6	Fair.
	111,732	11.1	
Coarse	131,426	13.0	Coarse.
Coarse brown	65,592	6.5	
	197,018	19.5	
Strings, tow and damaged	15,324	1.5	
Grand total	1,011,336	100.0	

TABLE C.—*Production of maguey (cantala), retted, in the Philippine Islands during the year 1915.*

District of production.	Standard grades.				Total.
	MGY-1	MGY-2	MGY-3	MGY-D & T.	
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*
Cebu	1,951	15,642	13,065	865	31,523
Ilocos	1,175	16,069	7,257	2,323	26,824
Bohol	20	493	478	41	1,032
Various	16	293	235	17	561
Total	3,162	32,497	21,035	3,246	59,940
Percentage	5.3	54.2	35.1	5.4	100

TABLE D.—*Production, by provinces, of abacá during the year 1915.*

ALBAY.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
January	127	210	211	237	101				201	21	10		246	140	188	54	4	1,750
February	204	344	612	851	1,268				4,357	526	294		4,415	1,674	3,690	2,516	201	20,952
March	126	248	625	839	923	28	11	6	4,189	276	341	843	5,826	1,690	2,255	1,040	296	19,562
April	67	117	596	537	284	39	10	11	900	173	198	2,631	3,987	1,413	1,772	1,119	298	14,152
May	66	131	557	862	312	28	21	6	237	53	136	1,437	8,234	2,237	11,248	3,418	372	29,355
June	95	139	539	750	357	57	41	26	173	58	106	941	5,337	2,037	6,395	3,178	224	20,453
July	41	135	528	507	324	62	29	14	318	118	153	1,272	6,986	2,486	7,784	2,463	224	23,444
August	9	80	341	336	156	38	23	20	141	67	93	789	4,032	1,953	6,433	1,635	173	16,319
September	4	96	237	206	158	30	8	12	153	121	111	1,317	5,790	2,607	8,187	2,272	157	21,466
October	4	62	393	481	152	13	6	10	131	125	158	729	3,730	1,733	5,666	1,515	264	15,172
November	63	210	621	295	169	33	11	7	151	117	147	1,127	5,130	2,154	8,087	2,435	316	21,073
December	41	145	330	385	262	30	5	4	198	148	261	1,524	8,261	3,530	9,271	4,368	625	29,388
Total	847	1,917	5,590	6,286	4,466	358	165	116	11,149	1,803	2,008	12,610	61,974	23,654	70,976	26,013	3,154	233,086
Percentage	0.4	0.8	2.4	2.7	2.0	0.2	0.1		4.8	0.8	0.8	5.4	26.6	10.1	30.5	11.1	1.3	100

LEYTE.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	Total.
January			3	216	611				349	123	64		79					1,445
February		12	73	1,107	5,654				5,389	1,410	1,018		2,389	497	58	70	245	17,922
March		64	25	695	5,411	115	261	226	8,154	2,050	2,078	1,681	4,956	1,472	537	145	306	28,176
April			24	716	4,647	1,512	1,394	774	7,259	1,722	1,333	4,150	2,193	1,020	233	13	482	27,472
May			15	351	3,356	1,001	1,362	607	6,763	1,398	1,101	3,889	2,857	738	203	15	296	23,952
June			99	799	3,757	1,285	1,571	520	6,121	1,648	1,410	5,307	3,512	1,139	142	12	476	27,798
July	2	9	25	125	1,635	583	796	427	3,923	1,314	973	4,298	3,211	841	46	18	228	18,454
August	1	4	95	639	3,901	1,398	1,426	484	5,764	1,640	1,063	5,040	3,190	802	13	3	370	25,833
September		12	33	300	1,892	439	622	293	4,044	1,641	964	5,502	4,171	942	7		705	21,567
October		12	116	958	3,241	682	764	404	5,015	1,933	1,046	6,283	3,215	743	29	1	398	24,840
November		8	85	633	2,467	596	737	361	4,435	1,949	1,245	7,233	4,484	862	19		338	25,452
December		3	58	559	2,175	518	686	276	4,281	2,084	1,369	6,713	4,228	774	15		497	24,236
Total	3	124	651	7,098	38,747	8,129	9,619	4,372	61,497	18,912	13,664	50,096	38,485	9,830	1,302	277	4,341	267,147
Percentage			0.2	2.7	14.5	3.0	3.6	1.6	23.0	7.1	5.1	18.8	14.4	3.7	0.5	0.1	1.7	100

TABLE D.—*Production, by provinces, of abacá during the year 1915*—Continued.

CAMARINES.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
January	174	256	414	447	274	------	------	------	150	49	10	------	37	12	9	14	3	1,849
February	191	602	681	456	241	------	------	------	234	89	27	------	403	125	397	250	24	3,720
March	181	604	1,061	659	229	53	15	3	183	31	6	81	475	152	1,294	797	37	5,861
April	158	543	824	769	325	140	96	4	132	27	22	120	554	224	2,838	2,132	80	8,988
May	202	384	634	575	200	125	109	24	168	115	11	257	447	278	4,039	2,279	83	9,930
June	142	440	850	840	253	98	84	11	90	46	37	135	566	264	5.311	4,116	160	13,443
July	320	561	737	489	170	37	15	2	92	79	8	223	746	473	5,318	2,897	182	12,349
August	87	323	640	487	119	73	46	------	55	70	48	261	745	301	4,620	2,210	98	10,183
September	280	442	635	412	174	107	34	2	83	25	23	173	588	267	4,291	1,770	115	9,421
October	98	200	453	210	123	71	21	2	150	54	14	148	700	200	2,927	1,221	71	6,663
November	51	279	320	201	109	37	21	6	32	6	13	85	581	346	4,916	1,808	85	8,896
December	59	172	281	148	85	36	7	6	85	37	42	382	1,180	387	4,676	2,112	221	9,916
Total	1,943	4,806	7,530	5,693	2,302	777	448	60	1,454	628	261	1,865	7,022	3,029	40,636	21,606	1,159	101,219
Percentage	1.9	4.8	7.4	5.6	2.3	0.8	0.4	------	1.4	0.6	0.3	1.8	7.0	3.0	40.2	21.4	1.1	100

SORSOGON.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	Total.
January	12	66	270	554	791	------	------	------	508	251	73	------	75	10	8	7	72	2,697
February	37	625	1,174	1,484	2,173	------	------	------	2,093	502	392	------	666	173	93	78	231	9,721
March	22	710	1,196	1,576	2,232	200	91	25	3,242	665	494	952	943	169	38	20	108	12,683
April	2	219	760	879	1,421	146	295	25	2,531	792	449	2,027	1,428	173	234	21	133	11,535
May	------	124	263	447	872	115	175	37	1,706	746	544	2,488	2,826	555	612	88	147	11,745
June	1	28	111	183	679	106	84	19	1,465	769	548	2,434	3,143	662	478	65	190	10,965
July	1	74	206	269	626	43	108	20	1,620	871	677	3,309	2,739	411	149	15	202	11,340
August	------	26	68	95	263	32	21	12	1,118	933	749	3,662	2,892	359	194	33	90	10,547
September	1	6	24	66	262	28	34	8	1,331	636	758	3,581	2,320	385	93	17	172	9,722
October	2	18	33	57	367	33	35	25	1,684	597	719	3,791	2,779	464	150	31	118	10,903
November	1	18	37	48	304	3	16	11	1,557	709	725	4,342	3,505	536	111	9	216	12,148
December	------	9	13	46	233	15	24	9	1,158	437	677	3,277	2,552	672	33	2	211	9,368
Total	79	1,923	4,155	5,704	10,223	721	883	191	20,013	7,908	6,805	29,863	25,868	4,569	2,193	386	1,890	123,374
Percentage	0.1	1.5	3.4	4.6	8.3	0.6	0.7	0.2	16.2	6.4	5.5	24.2	21.0	3.7	1.8	0.3	1.5	100

SAMAR.

January		1	43	177	314				421	129	20		5	2				1,112
February	6	24	98	517	1,211				1,550	760	123		34	7			43	4,373
March		41	298	1,159	2,576	326	369	155	2,444	783	137	166	143	16	171	87	52	8,923
April		55	236	977	2,042	374	855	239	2,055	759	110	257	33	20			57	8,069
May		95	344	784	2,057	572	849	337	1,897	632	38	451	29	12	12	1	59	8,169
June		16	339	1,356	3,234	1,034	1,607	454	3,573	629	65	644	48	3	2	1	113	13,118
July		23	272	1,330	1,790	648	738	348	1,979	290	91	287	77	22	9	5	61	7,969
August		62	316	1,726	2,440	690	689	221	1,936	246	20	214	16	1		1	35	8,613
September	15	105	417	1,662	2,787	756	985	291	2,570	338	51	284	15	1			64	10,341
October		42	386	1,519	2,355	605	691	150	1,766	264	40	175	2	3			15	8,013
November		8	161	944	2,910	630	922	267	2,410	378	32	359	13				137	9,171
December		22	206	628	2,087	461	823	216	2,104	310	20	379					115	7,371
Total	21	493	3,116	12,779	25,803	6,096	8,528	2,678	24,705	5,518	747	3,216	415	87	194	95	751	95,242
Percentage		0.5	3.3	13.4	27.1	6.4	8.9	2.8	25.9	5.8	0.8	3.4	0.4	0.1	0.2	0.1	0.8	100

NORTH MINDANAO.

January			21	79	164				277	65	19		260	166	490	278	81	1,900
February		8	68	612	1,724				1,200	391	121		657	590	409	698	108	6,586
March		12	70	619	2,086			1	2,218	695	247	522	743	334	180	377	87	8.191
April			34	580	2,032	188	256	122	1,574	335	64	1,036	509	556	258	948	189	8,681
May			29	399	1,362	215	238	100	1,864	480	95	1,652	484	599	327	1,924	247	10,015
June		1	21	471	2,298	332	516	260	1,706	358	122	1,115	379	611	913	2,285	287	11,675
July		1	23	283	1,396	203	284	210	1,912	221	57	1,038	437	262	421	785	153	7,686
August		1	13	262	1,539	189	276	135	1,959	236	107	1,580	722	319	447	392	139	8,316
September		2	29	488	1,989	203	218	106	1,682	170	93	850	357	223	701	582	143	7,836
October		4	104	779	2,034	270	257	139	2,109	208	58	886	383	188	380	316	144	8,259
November		4	116	740	2,037	213	305	88	1,830	196	68	669	301	178	466	427	106	7,744
December		1	93	529	1,790	244	201	54	1,337	159	51	426	302	152	404	159	149	6,051
Total		34	621	5,841	20,451	2,057	2,551	1,215	19,668	3,514	1,102	9,774	5,534	4,178	5,396	9,171	1,833	92,940
Percentage			0.7	6.2	22.0	2.2	2.7	1.3	21.2	3.8	1.2	10.5	6.0	4.5	5.8	9.9	2.0	100

TABLE D.—*Production, by provinces, of abacá during the year 1915*—Continued.

SOUTH MINDANAO.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
January	79	174	332	388	466				289	89	14						7	1,838
February	28	146	538	629	839				929	93	26		15				29	3,272
March	72	330	593	606	681	72	11	2	753	117	33	31	47		24	25	43	3,440
April	22	121	375	515	631	213	108	27	600	104	1	143	26	1			59	2,946
May	80	257	428	507	630	193	72	26	724	129	11	374	40				59	3,530
June	116	309	603	684	920	233	71	14	885	99	1	366	25				97	4,423
July	66	228	518	653	613	178	32	13	569	82	3	375	16		23	10	67	3,446
August	19	96	272	411	507	215	64	49	967	140	6	381	7				66	3,200
September	23	119	347	293	334	158	40	11	411	47	2	124	37		6	4	29	1,985
October	31	125	264	301	331	141	38	9	405	42	2	154					52	1,895
November	24	92	235	275	337	196	37	5	395	41	2	106					38	1,783
December	267	293	433	397	327	74	21	7	456	82	4	156					45	2,562
Total	827	2,290	4,938	5,659	6,616	1,673	494	163	7,383	1,065	105	2,210	213	1	53	39	591	34,320
Percentage	2.4	6.7	14.7	16.5	19.3	4.9	1.4	0.5	21.5	3.1	0.3	6.4	0.6		0.1	0.1	1.6	100

CAVITE.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T	Total.
January	535	358	267	20	3													1,183
February	733	474	217	25													9	1,458
March	733	606	239	15													12	1,605
April	496	380	94	1													12	983
May	623	463	136	1		1											37	1,261
June	512	528	100		12												31	1,183
July	446	447	172	2	1	24											67	1,159
August	259	268	82	4													18	631
September	275	242	76	11	8	2	1										7	622
October	226	182	88	9	3												41	549
November	82	78	47	16													6	229
December	245	189	58	5													6	503
Total	5,165	4,215	1,576	109	27	27	1										246	11,366
Percentage	45.4	37.1	13.9	1.0	0.2	0.2											2.2	100

MINDORO.

January		57	295	103	34				15	4								508
February	1	62	172	131	99				69	22							1	557
March	5	168	521	291	108		3		57	11		3					1	1,168
April		18	118	73	16	2			5	1								233
May	1	17	126	69	13				4			2	2					234
June		26	146	187	72	1	12	1	80	7		2	7					541
July		46	351	432	157	1	4	1	33	1								1,026
August		53	624	649	121	4	10	1	20			3	7		2		2	1,496
September		38	472	426	76	8	10	4	19				2				2	1,057
October		36	267	273	55	1	4		2								1	639
November		23	120	102	35	2	2	3										287
December		21	186	238	90	3	1		21			6						566
Total	7	565	3,398	2,974	876	22	46	10	325	46		16	18		2		7	8,312
Percentage		6.8	40.9	35.8	10.5	0.3	0.6	0.1	3.9	0.6		0.2	0.2					100

TAYABAS.

January		35	114	134	54				5									342
February		50	188	181	63				8				2		39	31		562
March		41	189	261	313				150	50			23		234	15	1	1,277
April		80	211	159	39	1			10						309	185		994
May		51	246	370	193				43			3	2		889	293		2,090
June		18	78	222	146				49				9		884	110		1,516
July		9	32	61	29		3		12				2		135	8	1	292
August				2	3	14	3		1	1					558	39	2	623
September									3			6	12		507	42		570
October									1			1	10		505	36		553
November		2	5	3	1								10	2	192	18		233
December					1							1	18	2	356	56		434
Total		286	1,063	1,393	842	15	6		282	51		11	88	4	4,608	833	4	9,486
Percentage		3.0	11.2	14.7	8.9	0.2			3.0	0.5		0.1	0.8		48.7	8.9		100

TABLE D.—*Production, by provinces, of abacá during the year 1915*—Continued.

CEBU.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
January			9	41	45				32	3							1	131
February		3	20	302	542				193	35	35		15	5		7	237	1,394
March			5	169	414				246	69	39		27	2			154	1,125
April			12	152	302	226	58	30	88	43	28	34	53	191	191	313	61	1,782
May			12	232	480	295	83	24	78	29	5	11	4	72	5	128	19	1,477
June			5	147	342	235	47	13	74	11	5	19	5				12	915
July			1	68	370	197	58	17	92	11	15	63	13	3	1		37	946
August		8	32	94	171	69	11	13	26	4	2	18	2		4		24	478
September		2	18	86	130	46	15	12	25	10	13	20	10	5	2	1	15	410
October		1	6	50	103	47	10	3	32	12	5	8	3	1			3	284
November		2	9	35	90	40	13	5	28	14	7	17	4	1			24	289
December		1	14	71	194	72	14	6	63	20	7	31	11	5	6	1	24	540
Total		17	143	1,447	3,183	1,227	309	123	977	261	161	221	147	285	209	450	611	9,771
Percentage		0.2	1.5	14.8	32.6	12.6	3.1	1.3	10.0	2.6	1.7	2.3	1.5	2.9	2.1	4.6	6.2	100

VARIOUS.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	O. Y. T.	Total.
January	86	132	61	71	91				29	3							12	485
February	36	159	183	132	141				136	22	4		3	7		6	31	860
March	107	185	198	196	181	8	4		133	10	1	15	21	140	50	264	75	1,588
April	127	141	112	63	139	24	33	4	136	68	7	30	47	162	116	376	43	1,628
May	88	55	137	317	314	36	54	6	101	68	59	26	36	174	97	730	160	2,458
June	122	90	110	174	223	26	42	8	187	51	17	48	54	199	406	1,478	69	3,304
July	77	108	165	292	220	12	35	11	146	41	16	38	31	36	446	426	99	2,199
August	26	43	87	149	118	15	11	2	67	11	3	30	30	61	974	843	56	2,526
September	9	39	83	162	113	16	4	10	33	2		3	107	164	1,949	1,711	92	4,497
October	39	70	106	253	247	46	23	4	116	13		34	67	37	414	157	27	1,653
November	25	61	168	167	91	25	9	2	43	10	2	10	84	84	712	385	28	1,906
December	44	62	132	202	186	25	6	1	70	4	2	16	77	58	693	346	45	1,969
Total	786	1,145	1,542	2,178	2,064	233	221	48	1,197	303	111	250	557	1,122	5,857	6,722	737	25,073
Percentage	3.1	4.6	6.1	8.7	8.2	0.9	0.9	0.1	4.8	1.2	0.5	1.0	2.2	4.4	23.4	26.8	3.1	100

TABLE E.—*Production of maguey (cantala), retted, in Ilocos, Cebu, Bohol, and other Provinces during the year 1915.*

ILOCOS.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	O-T.	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
January		58	715	131		904
February		24	324	53	12	413
March	7	1,104	909	351		2,371
April	159	2,043	526	102		2,830
May	141	3,513	1,304	535	2	5,495
June	43	3,918	1,573	859		6,393
July	31	2,102	859	180		3,172
August	3	408	154	25		590
September	2	301	179	11		493
October	1	673	257	31		962
November	75	679	249	22		1,025
December	713	1,246	208	9		2,176
Total	1,175	16,069	7,257	2,309	14	26,824
Percentage	4.4	59.9	27.1	8.6		100

CEBU.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	O-T.	Total.
January	27	700	112	2		841
February	216	896	1,095	23		2,230
March	134	1,226	990	13		2,363
April	88	1,554	1,810	93		3,545
May	82	1,638	2,613	147		4,480
June	61	1,350	1,484	86		2,981
July	59	1,171	1,593	186		3,009
August	128	1,380	1,098	88		2,694
September	210	1,381	866	90		2.547
October	170	767	334	39		1,310
November	269	1,384	440	37		2,130
December	507	2,195	630	61		3,393
Total	1,951	15,642	13,065	865		31,523
Percentage	6.2	49.6	41.4	2.8		100

BOHOL.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	O-T.	Total.
January						
February		5	23			28
March		49	35			84
April						
May						
June	1	43	84	13		141
July						
August	13	158	149	13		333
September	2	102	84	6		194
October						
November	4	136	103	9		252
December						
Total	20	493	478	41		1,032
Percentage	1.9	47.8	46.3	4.0		100

OTHER.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	O-T.	Total.
January						
February						
March						
April		9	7			16
May	1	27	51	3		82
June						
July	2	37	19	1		59
August						
September	1	10	3			14
October	4	85	46	8		143
November	3	7				10
December	5	118	109	5		237
Total	16	293	235	17		561
Percentage	2.9	52.2	41.9	3.0		100

FIBER-GRADING STATIONS AND GRADING ESTABLISHMENTS.

By M. M. SALEEBY, *Chief, Fiber Division.*

During the latter part of the year 1914 the Director of Agriculture, in accordance with Section 3 of Act 2380 of the Philippine Legislature, designated the grading stations throughout the Islands where all fibers included in the above-mentioned Act might be graded and baled for export. Grading permits were later issued to all qualified grading establishments located in the different grading stations. Fiber inspectors were simultaneously assigned to the more important stations, and the establishments at the minor stations were required to submit their fiber for inspection on its arrival at Manila or Cebu, where special inspectors were detailed for that purpose.

There are now 28 designated grading stations distributed among 10 provinces, and 89 grading establishments have been issued grading permits. The following table gives the names and location of the different stations and the number of establishments in each:

Province and grading station.	Grading establishments.
Rizal: Manila	17
Cebu: Cebu	4
Albay:	
Legaspi	7
Tabaco	7
Ligao	1
Virac	2
Total	17
Ambos Camarines:	
Naga	7
Lagonoy (district) [a]	8
Daet	4
Total	19
Sorsogon:	
Sorsogon	3
Gubat	3
Casiguran	2
Bulan	1
Total	9
Leyte:	
Tacloban	4
Carigara	3
Palompon	1
Maasin	1
Malitbog	1
Total	10
Samar:	
Calbayog	5
Catbalogan	1
Laoang	1
Catarman	1
Total	8
Surigao: Surigao	2
Misamis: Cagayan	1
Tayabas: Mauban	2
Grand total	89

[a] This district includes four grading stations.

The above grading establishments were classified as follows: First class, 10; second class, 5; third class, 7; fourth class, 21; fifth class, 20; and sixth class, 27. The class of the establishment is determined by the number of bales graded and baled per year. First-class establishments handle 40,000 bales or more; second class, 20,000 to 40,000; third class, 16,000 to 20,000; fourth class, 8,000 to 16,000; fifth class, 4,000 to 8,000; and sixth class, under 4,000 bales.

The majority of grading establishments have discontinued the use of their old house marks, and have registered only one mark to be used in connection with all grades, the designation of the grade being made by the use of the official letter. This greatly simplifies the marking of bales and facilitates the indentification of the grade, These marks are known as press marks, to distinguish them from the old house marks. The following list gives the names of the grading establishments, their locations, press marks, and the lot numbers allotted to them. A blank in the "Press marks" column signifies that the establishment uses a special house mark for each grade. These house marks are given in another list.

Name of establishment.	Press mark.	Grading station.	Lot numbers.	Class of establishment.
Adriano Favorito	A F	San Sosé, Lagonoy	22,701-22,800	Sixth.
Angel Camara	J C	Gubat, Sorsogon	5,701- 5,900	Fifth.
Ang Siliong[a]	T T	Legaspi, Albay	21,901-22,100	Sixth.
A. Chan Linte	A O	Calbayog, Samar	22,601-22,700	Fourth.
A. T. Hoehener[a]	B M	do	20,701-20,900	Fifth.
B. A. Lim Biengco	B A	San José, Lagonoy	2,401- 2,600	Sixth.
Balbino Campa	B C	Mauban, Tayabas	22,101-22,300	Sixth.
Carlos Delgado	C D	Catarman, Samar	18,701-18,900	Sixth.
Colea & Co	C F	San José, Lagonoy	6,101- 6,300	Sixth.
C. Itoh & Co		Manila	11,301-11,500	Fifth.
D. B. Monasterio	D B M	San José, Lagonoy	17,301-17,500	Sixth.
Do	J G	Tigaon, Lagonoy	17,501-17,700	Fifth.
Dy Buncio & Co	D B C	Tabaco, Albay	12,101-12,500	Fourth.
Do	N D B C	Naga, Camarines	12,501-12,700	Fifth.
Dy Chi Chuan & Co	D C C	Calbayog, Samar	23,001-24,000	Sixth.
E. Diaz & Co	E D C	Legaspi, Albay	3,501- 3,800	Third.
E. Schulz & Co.[a]		Manila	11,101-11,300	Sixth.
Fausto Ormachea	F O	Tabaco, Albay	13,901-14,200	Fifth.
Fernandez Hermanos		Manila	16,801-17,000	Sixth.
Findlay, Richardson & Co., Ltd		do	8,001- 8,100	Sixth.
Gabino Barretto	P T S	Tacloban, Leyte	21,501-21,800	Third.
Germann & Co., Ltd		Manila	3,101- 3,300	Sixth.
G. Martini	G M M	do	15,201-15,400	Fourth.
Gutierrez Hermanos		Legaspi, Albay	1,101- 1,600	Fourth.
Do		San José, Lagonoy	1,601- 1,800	Fifth.
Do		Maasin, Leyte	1,801- 2,000	Fifth.
Do		Naga, Camarines	2,001- 2,200	Sixth.
Do		Bulan, Sorsogon	2,201- 2,400	Fourth.
G. Urrutia & Co		Daet, Camarines	901- 1,100	Sixth.
Hijos de Joséfa Pastrana & Co	H J P	Mauban, Tayabas	19,701-19,900	Sixth.
I. Ihara		Manila	17,001-17,200	Sixth.
Jao Juntiao & Co	J T	Sorsogon, Sorsogon	5,501- 5,700	Fourth.
Joaquin Muños & Co		Legaspi, Albay	16,401-16,800	Third.
Juan Navas Sioca & Co	J N S	Catbalogan, Leyte	18,901-19,100	Fifth.
Juan Pimentel	J P	Daet, Camarines	19,501-19,700	Sixth.
Ker & Co		Manila	4,501- 4,700	Second.
Do		Cebu, Cebu	4,301- 4,500	Second.

[a] Discontinued during 1916.

Name of establishment.	Press mark.	Grading station.	Lot numbers.	Class of establishment.
Lim Ueco	L V	Gubat, Sorsogon	15,801-16,000	Fifth.
Li Seng Giap & Co	D L S G	Daet, Camarines	14,401-14,600	Fifth.
Do	N L S G	Naga, Camarines	14,201-14,400	Fifth.
Do	L S G	Tabaco, Albay	22,501-22,600	Fourth.
Lutz & Co		Manila	17,201-17,300	Sixth.
Macleod & Co., Inc	M A C	do	12,901-13,400	First.
Do	P C	Cebu, Cebu	13,401-13,900	First.
Manuel Oria Gonzalez [b]	L C	Laoang, Samar	15,401-15,600	Fifth.
Martin de Achaval	A D	Ligao, Albay	19,301-19,500	Fourth.
Miguel Sanches	M S	Naga, Camarines	21,801-21,900	Sixth.
Mitsui Bussan Kaisha, Ltd		Manila	11,901-12,100	Fourth.
Muertegui y Aboitiz		Palompon, Leyte	19,901-20,100	Fourth.
M. Tagawa		Manila	12,701-12,900	Sixth.
Narciso Alegre		Casiguran, Sorsogon	3,801- 4,300	Second.
Ohta Developement Co		Manila	7,301- 7,500	Fifth.
Ong Saco & Co	O H C	Daet, Camarines	22,901-23,000	Sixth.
Ortiga Hermanos [a]	P O or L Y	Tacloban, Leyte	4,701- 5,200	First.
Do	O H	Calbayog, Samar	5,201- 5,500	Third.
Do	L T	Carigara, Leyte	24,001-24,200	Fifth.
Pacific Commercial Co		Manila	16,001-16,400	First.
Pardo & Co	N P	Naga, Camarines	18,201-18,400	Sixth.
Salustiano Zubeldia	S Z	Tabaco, Albay	17,901-18,200	Fourth.
Siy Cong Bieng & Co	S C B	Sagnay, Lagonoy	20,901-21,200	Fourth.
Do	N S C B	Naga, Camarines	21,201-21,500	Fourth.
Smith Bell & Co		Manila	8,101- 8,700	First.
Do		Cebu, Cebu	8,701- 9,300	First.
Do		Legaspi, Albay	9,301- 9,800	Second.
Do		Tabaco, Albay	9,801-10,300	First.
Do		Virac, Albay	10,301-10,600	Fifth.
Do		Cagayan, Mindanao	10,601-10,900	Fifth.
Do		San José, Lagonoy	20,401-20,700	Sixth.
Tan Jong Yu	J Y	Virac, Albay	10,901-11,100	Fifth.
Tan Quion Quin & Co	T G	Casiguran, Sorsogon	5,901- 6,100	Fourth.
Tan Sen Guan Hermanos & Co	G S	Tacloban, Leyte	22,801-22,900	Third.
Do	T G S	Carigara, Leyte	24,201-24,400	Fifth.
Torribio Reyes Chua Yu	T R U	Naga, Camarines	14,601-14,800	Sixth.
Ty Chuaco & Co	T C	Tabaco, Albay	22,301-22,500	Fourth.
Uy Gui Hian	U G H	do	20,101-20,400	Fourth.
Vda. é Hijos de Chua Piengco	C P	Sorsogon, Sorsogon	14,801-15,000	Sixth.
Vda. é Hijos de F. Escaño		Malitbog, Leyte	15,001-15,200	Fourth.
Vela Hermanos	V H	Iriga, Camarines	24,001-25,000	Sixth.
Warner, Barnes & Co., Ltd	W B	Manila	18,401-18,700	Sixth.
W. F. Stevenson & Co., Ltd		do	6,301- 6,800	First.
Do		Cebu, Cebu	6,801- 7,300	First.
Yap & Co		Legaspi, Albay	15,601-15,800	Fourth.
Yap Tec Teng		do	19,101-19,300	Fourth.
Ynchausti & Co		Sorsogon, Sorsogon	7,501- 7,800	Third.
Do		Gubat, Sorsogon	7,801- 8,000	Fourth.
Yu Biao Sontua	D O P	Tacloban, Leyte	2,601- 3,100	First.
Do	Y B S	Calbayog, Samar	400- 900	Second.
Do	C B	Carigara	3,301- 3,500	Third.
Yu Biao Sontua & Co	H C	Surigao, Mindanao	1- 399	Fourth.
Yusingco Hermanos	A Y S	do	25,001-25,200	Fourth.

[a] Discontinued during 1916.
[b] P. O. from Grades A to S_3, and L. Y. from F. to M.

The following list gives the names of those grading establishments which still use old house marks, together with the corresponding house mark for each of the official grades of abacá:

Registered house marks.

ABACÁ (MANILA HEMP).

Grading establishment and station.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.
C. Itoh & Co., Manila	CI I	CI S	CI M	CI N	CI O	CI K1	CI K2	CI K3	CI R	CI V	CI T	CI A	CI B	CI BB	CI C	CI CC
Fernandez Hermanos, Manila	FH K	FH L	FH P	FH R	FH S				FH T	FH X	FH XX		FH DF	FH DM	FH DC	FH DX
Findlay, Richardson & Co., Ltd., Manila.	FIN	LAY	RIC	FRD	FRE				FRF	FRG	FRH	FRI	FRJ	FRK	FRL	
Germann & Co., Ltd., Manila	GC 1 YZ	GC L YZ	GC 2 YZ	GER 4	GER 5	GER L1	GER L2	GER L3	GER 6	GER 8	GER 9	GER 7	GER 10	GER 11	GER 12	GER 13
I. Ihara, Manila	II SS	II S	II A	II B												
Ker & Co., Manila	KL	KC L	KK	K	WW	YT	SS	BB	YB	KS	KB	SU	1U	2U	CD	CB
Mitsui Bussan Kaisha, Manila	OTS EX	OTS SS	OTS S	OTS A	OTS B	OTS X	OTS XX	OTS XXX	OTS C	OTS D	OTS E	OTS F	OTS G	OTS H	OTS I	OTS J
M. Tagawa, Manila	JMT	TGW	SS	GG	MX				FF							
Ohta Development Co., Manila	KSO SSS	KSO ES	KSO SS	KSO AA	KSO BB				KSO CC		KSO HH					
Pacific Commercial Co., Manila	CBW A	CBW BB	CBW C	CBW D	CBW E	CBW LC	CBW LS	CBW LR	CBW HF	CBW N	CBW X	CBW KK	CBW P	CBW S	CBW SC	CBW SB
Smith, Bell & Co. Ltd., Manila	SB A	LSB B	PBD L	MSB B	SB FC	MSW FF	MSW GG	MSW HH	MSW F	MSW G	MSW H	MSW Z	MSW SK	MSW R	MSW S	MSW C
W. F. Stevenson & Co., Ltd., Manila	B SM	SM GC	CMM C	C SM	E SM	X SM	SMX X	LR SM	SM2 2	SN 2	SN R	SN C	MP C	NG 2	DC C	DR
Ker & Co., Manila	KC WW	KC W	KC BC	KC CU C	KC GS	KC LR	KC RS	KC XL	KC ND	KC GC	KC HC	KC SM	KC CU	KC R	KC M	KC X
Smith, Bell & Co., Ltd., Manila	SB M	SB LM	SB CS	SB GC	SB MM	SB FT	SB 2	SB LG R	SB W	SB N	SB 3	SB Z	SB MR	SB X	CSB S	CSB C
W. F. Stevenson & Co., Ltd., Albay	ASC A	BSC B	CSC C	MN B	MN C	RSC R	XSC X	MN E	MN S	MN R	MN X	FMN M	MN M	4MN G	MN CX	MN BX
Gutierrez Hermanos, Legaspi	GH AAA	GH AA	GH AL	GH SL	GH SB				GH LC	GH XX	GH XXX	GH LD	GH C	GH CC	GH S	GH R
Joaquin Muños, Legaspi	JMC Z	JMC SS	JMC S	JMC AAA	JMC AA	JMC S1	JMC S2	JMC S3	JMC AB	JMC AG	JMC AH	JMC AC	JMC AL	JMC A1	JMC L	JMC X

Registered house marks—Continued.

ABACÁ (MANILA HEMP)—Continued.

Grading establishment and station.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.
Smith, Bell & Co., Ltd., Legaspi				LSW D	LSW E	LSW FF	LSW GG	LSW HH	LSW F	LSW G	LSW H	LSW Z	LSW SK	LSW R	LSW S	LSW C
Smith, Bell & Co., Ltd., Virac				VSW D	VSW E	VSW FF	VSW GG	VSW HH	VSW F	VSW G	VSW H	VSW Z	VSW SK	VSW R	VSW S	VSW C
Smith, Bell & Co., Ltd., Tabaco				TSW D	TSW E	TSW FF	TSW GG	TSW HH	TSW F	TSW G	TSW H	TSW Z	TSW SK	TSW R	TSW S	TSW C
Yap & Co., Legaspi	AAA	AA	A	W	E	LF	LB	LR	L	OC	U	CC	C	M	S	T
Yap Tec Teng, Legaspi	YT No. 1	YT No. 2	YT No. 3	YT AAA	YT SSS	YT S1	YT S2	YT S3	YT BB BS	YT G	YT H	YT CB	YT CC	YT K	YTK No. 1	YT TB
Gutierrez Hermanos, Bulan		GH SSS	GH SS	GH IS	GH A	GH F	GH	GH	GH AC	GH D	GH Z	GH H	GH	GH 2	GH NG	GH ZZ
Narciso Alegre, Casiguran	NA A	NA CB	NA C	NA SB	NA B	NA X	NA XX	NA Z	NA 1	NA 3	NA 4	NA 2	JBA	JBA 2	JBA 3	JBA X
Ynchausti & Co., Sorsogon	SΔ B	SΔ A	SΔ AA	SD H	SD 2	SD 2F	SD CF	SD RF	SD R	SD X	SD XX	SD RR	SD G4	SD G5	SD D	SD DD
Ynchausti & Co., Gubat	VΔT B	VΔT A	VΔT AA	VΔT H	VΔT 2	VΔT 2F	VΔT J	VΔT RF	VΔT R	VΔT X	VΔT XX	VΔT RR	VΔT G4	VΔT G5	VΔT D	VΔT DD
Gutierrez Hermanos, Maasin		FA B	FA C	FA CC	FA CCC				FA MC	FA X	FA XX					
Muertegui y Aboitiz, Palompon	PMA A	PMA B	PMA C	PMA CC	PMA R	PMA X	PMA XX	PMA XXX	PMA Q	PMA QQ	PMA QQQ	PMA I				
Vda, E Hijos de F. Escaño, Malitbog	AFE A	BFE B	SFE S	AFE M	BFE M	RFE R	XFE X	LFE X	SFE M	RFE M	XFE M	CFE M	DFE M	EFE M	FFE M	GFE M
Gutierrez Hermanos, San Jose (Lagonoy).												BGH L	CGH L	DGH L	2GH L	3GH L
Gutierrez Hermanos, Naga												GH J	GH G	GH GG	GH N	GH X
G. Urrutia & Co., Daet	D GUC SSS	D GUC SS	D GUC S	D GUC A	D GUC B	D GUC S1	D GUC S2	D GUC S3	D GUC C	D GUC D	D GUC E	D GUC GF	D GUC FC	D GUC MS	D GUC G1	D GUC G2
Smith, Bell & Co., Ltd., Nato (Lagonoy).				LA SW D	LA SW E	LA SW FF	LA SW GG	LA SW HH	LA SW F	LA SW G	LA SW H	LA SW Z	LA SW SK	LA SW R	LA SW S	LA SW C
Smith, Bell & Co., Ltd., Cagayan	KSB M	KSB LM	KSB CS	KSB GC	KSB MM	KSB FT	KSB 2	KSB LGR	KSB W	KSB N	KSB 3	KSB Z	KSB MR	KSB X	KC SB S	KC SB C

MAGUEY (CANTALA), RETTED.

Name of establishment.	Grading station.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Name of establishment.	Grading station.	MGY-1.	MGY-2.	MGY-3.	MGY-D.
C. Itoh & Co	Manila	CI M1	CI M2	CI M3	CI M4	Pacific Commercial Co	Manila	CBW MGY1	CBW MYG2	CBW MGY3	CBW MGY4
Fernandez Hermanos	do	FH 1	FH 2	FH 3	----	Smith Bell & Co., Ltd	do	MSW MG1	MSW MG2	MSW MG3	MSW MGPP
Germann & Co., Ltd	do	GER M1	GER M2	GER M3	----	W. F. Stevenson & Co., Ltd.	do	A1 MGY	B2 MGY	C3 MGY	D4 MGY
Ker & Co	do	K1	K2	K3	K4	Ker & Co	Cebu	KC M1	KC M2	KC M3	----
Macleod & Co., Inc	do	MC M1	MC M2	MC M3	MC MD	Macleod & Co., Inc	do	PC M1	PC M2	PC M3	PC M5
Mitsui Busan Kaisha	do	OTS M1	OTS M2	OTS M3	----	Smith, Bell & Co., Ltd	do	SB MG1	SB MG2	SB MG3	SB MGPP
M. Tagawa	do	SSS	SS	S	----	W. F. Stevenson & Co., Ltd.	do	A1 SC	B2 SC	C3 SC	D4 SC

CURRENT NOTES—FIRST QUARTER.

By M. M. SALEEBY, *Chief, Fiber Division.*

CARLUDOVICA PALMATA IN THE PHILIPPINES.

About eight years ago, the Bureau of Agriculture imported a quantity of seed of *Carludovica palmata* (panama-hat plant) from Central America. This seed was planted at the Lamao experiment station, and owing to the poor condition in which it arrived only two plants were obtained. These plants, however, grew rapidly, and luxuriantly, and in 1913 some 50 shoots were secured and set out in a separate plot. These also grew and developed rapidly like the mother plants, part of them being later transferred to the La Carlota experiment station.

During 1915, the plants at both experiment stations had grown and developed to such an extent as to leave no doubt as to the practicability of cultivating this plant in the Philippine Islands, and as to the suitability of both soil and climatic conditions here. The results were so encouraging that the Bureau of Agriculture furnished more than 100 plants to the Bureau of Education for planting in school gardens in those provinces where hat weaving is an important household industry. The Filipinos are known to be particularly skilful in weaving fine and exquisite hats, and it is hoped they will be able to show the same ingenuity in weaving panama hats. As far as the operation of weaving a panama hat is concerned, the Filipino can be depended upon to rival the hat weaver of Central America. The only phase of the problem which awaits solution is the knowledge of the proper preparation of the leaves. It is hoped that the Bureau of Education will succeed in its efforts to establish and build up this trade, and thus add one more to its many notable achievements in Philippine industrial work.

ROSELLE FIBER.

In connection with investigations as to the possibilities of growing roselle (*Hibiscus sabdariffa*) for its flower, the division of plant industry of this Bureau discovered two varieties which

grow to a greater height than the ordinary varieties and produce a rather inferior flower. These two varieties, the white and the red, were, on account of their growth, believed to be suitable for fiber production, and were, therefore, taken up later by the fiber division. Experiments conducted on a small scale by the latter division proved that these varieties thrive and develop much more rapidly and luxuriantly than either *Hibiscus cannabinus* or jute. Their fiber also appears to be equal to that of jute, if not actually superior to it, and should make a suitable substitute for the latter in the manufacture of bags and such other articles as are now made of jute.

Experiments in the growing of roselle for fiber production will be continued this year on a larger scale than heretofore, with the ultimate object of determining definitely the most practicable method of cleaning the fiber, and the actual yield that can be expected from it. This subject assumes particular importance at this time in view of the probable increased demand for burlap bags in the Philippines as a result of the recent movement to install and operate more modern sugar mills in the Islands, and also as a result of the probable increase in rice prodution.

ABACÁ AS PARTIAL SUBSTITUTE FOR JUTE.

The writer was advised some time ago by a gentleman connected with the sugar industry in the Hawaiian Islands that some dissatisfaction had recently been shown in regard to the use of burlap (jute) bags in the shipment of sugar. The cause of dissatisfaction appears to be the lack of sufficient strength in the jute bags, with the result that when a large number of bags of sugar are piled up in the holds of steamers the weight causes the bags in the lower tiers to burst. Such a condition can only be remedied either by the use of a stronger fiber for making the bags, or by dividing the holds into two or three compartments located one above the other in order to reduce the pressure to which the bags at the bottom are subjected.

The necessity for a stronger fiber than jute to be used either as a substitute for, or a mixture with, the latter, has suggested the possibility of using certain forms of the abacá fiber for this purpose. Abacá tow, strings and some of the pacol or canton grades may be used, as their cost is not prohibitive. The supply of such fibers, however, is not sufficient to recommend them as substitutes for jute, but they may be used for mixture with this fiber.

To the above fibers, abacá of the "Coarse brown" and the

so-called "Daet" grades, and maguey of the grades No. 3 and damaged, may be added as possible sources of supply, as the value of these grades in normal times rarely exceeds that of jute.

During the year 1915 there were produced in the Philippine Islands about 95,000 bales[1] of abacá of the "Coarse brown" and the "Daet" grades, 12,000 bales of strings and tow, 21,000 bales of "Maguey No. 3" and 3,246 bales of "Maguey, damaged," making a total available supply of over 130,000 bales of raw material.

AGAVE IN THE PHILIPPINES.

Of the commercial species of *Agave,* four are grown in the Philippine Islands. These are maguey (*Agave Cantala,* Roxb.), sisal (*A. sisalana*), henequen (*A. fourcroydes*), and zapupe (*A. zapupe*). The first two are grown on a somewhat large scale, and their fiber is regularly exported, almost exclusively in the retted form. The last two species were introduced three years ago by the writer, through the courtesy of Mr. L. H. Dewey of the United States Department of Agriculture, and were planted in separate plots in the section reserved for *Agave* at the La Carlota experiment station.

Maguey.—This plant has been grown in the Philippine Islands for a long time, but its fiber did not become an article of commerce until about eleven years ago. The plant was introduced from tropical America by the Spaniards, and the only other countries where it is now grown to any extent are Java and British India. It is said that this species is now entirely extinct in tropical America, from which region it must have been introduced to the eastern Tropics. The maguey fiber properly cleaned by machinery is whiter, finer, and softer than either sisal or henequen, and equal to the latter in tensile strength. Under favorable conditions, and with proper cultivation and harvesting of leaves, the life of the plant averages about ten years.

Sisal.—This species was introduced into the Philippine Islands from Hawaii in 1905 by the Bureau of Agriculture. Its cultivation in these Islands has not become as extensive as that of maguey. The retting process used in fiber extraction eliminates to a considerable extent the natural characteristics of both maguey and sisal, hence until the operation of the fiber-grading law, both fibers were known in the market by the same name—maguey or Manila maguey.

[1] A bale of abacá or maguey weighs about 125 kilos net (275 pounds), making approximately 8 bales to the metric ton.

Sisal fiber, when properly cleaned by machinery, is harder and slightly more yellowish than maguey. The so-called Java sisal is mostly maguey, which accounts for the particular softness of that fiber. As sisal fiber is larger than the maguey fiber, the yield of the former plant is generally greater than the latter. This practically constitutes the only advantage sisal has over maguey.

The life of the sisal plant in the Philippine Islands rarely exceeds seven years.

Henequen and zapupe.—The few plants of these two species grown at the La Carlota experiment station have not yet attained maturity, and no data are available as to the character of their fibers. As far as development is concerned, they have exhibited a remarkably luxuriant growth, which compares very favorably with that of maguey and sisal. Henequen as produced in Yucatan, Mexico, is of a reddish-yellow color and of a harsh texture. It will be interesting to learn if these same characteristics will hold in fiber produced in these Islands, where both soil and climatic conditions are very different from those of Yucatan.

Unless henequen and zapupe exhibit qualities superior to those of maguey and sisal, the writer will not recommend the cultivation of the two former species in these Islands, for fear of the unavoidable mixture of these fibers on the market which may cause uncertainty as to quality on the part of foreign buyers.

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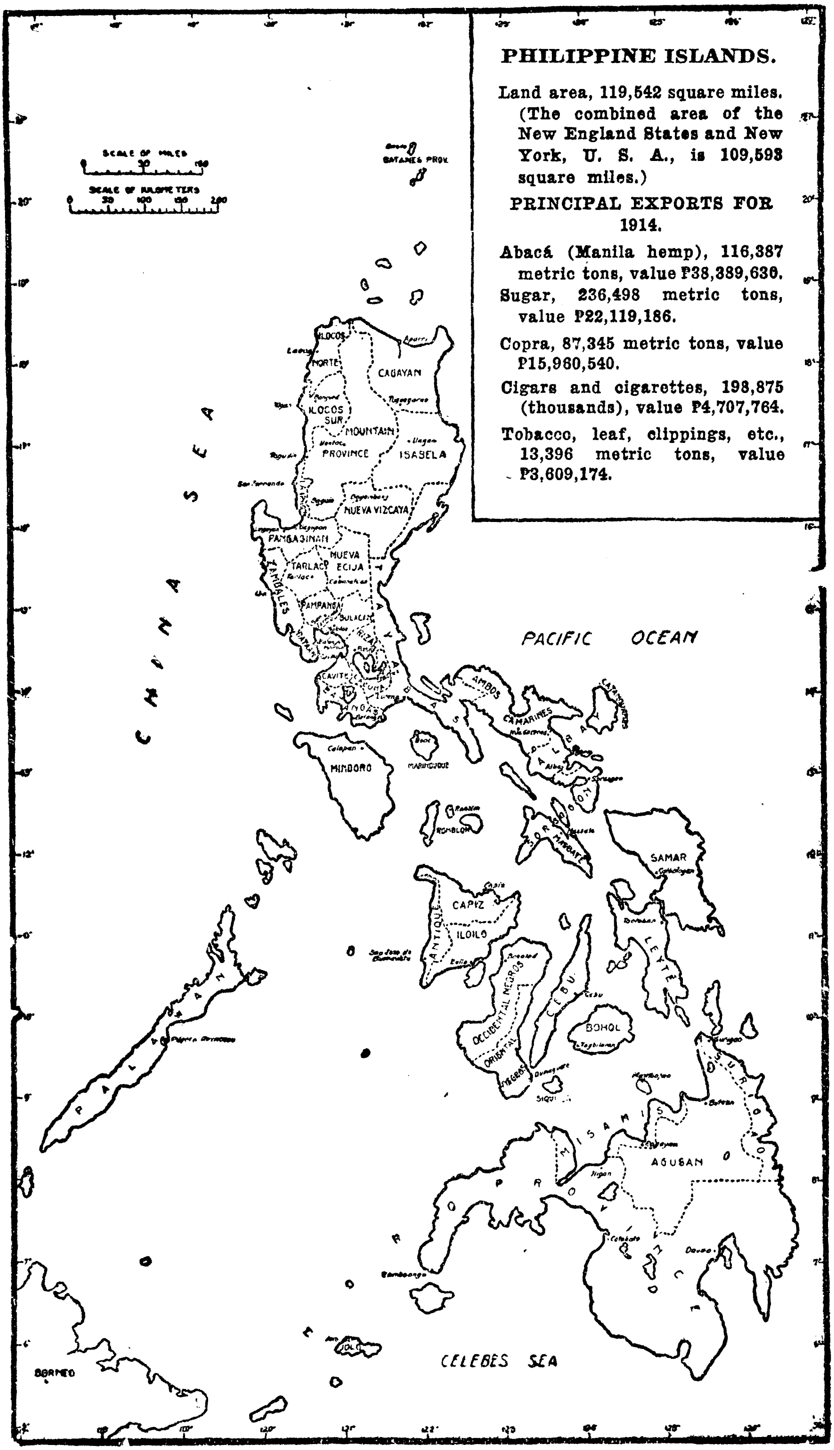
PHILIPPINE ISLANDS.
Land area, 119,542 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1914.
Abacá (Manila hemp), 116,387 metric tons, value ₱38,389,630.
Sugar, 236,498 metric tons, value ₱22,119,186.
Copra, 87,345 metric tons, value ₱15,960,540.
Cigars and cigarettes, 193,875 (thousands), value ₱4,707,764.
Tobacco, leaf, clippings, etc., 13,396 metric tons, value ₱3,609,174.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
RIZAL
BATAAN
CAVITE
TAYABAS
BATANGAS
CHINA SEA
PACIFIC OCEAN
AMBOS CAMARINES
ALBAY
CATANDUANES
SORSOGON
MINDORO
MARINDUQUE
ROMBLON
MASBATE
SAMAR
CAPIZ
ANTIQUE
ILOILO
LEYTE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
PALAWAN
SURIGAO
MISAMIS
AGUSAN
MORO PROVINCE
JOLO
CELEBES SEA
BORNEO

UNIV. OF MICH.

Courtesy of the Department of Agriculture, Buitenzorg, Java.

Fullgrown and topped coffee of the Robusta type (planted somewhat farther apart than is customary in field practice), shaded by malaganit, with *Centrosema plumierii* as a cover crop. Tjikeumeuh Experiment Station, Buitenzorg.

THE PHILIPPINE

Agricultural Review

VOL. IX SECOND QUARTER, 1916 No. 2

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RICE INVESTIGATIONS.

Throughout the greater part of the Philippine Islands rice has long been, and undoubtedly will long continue to be, the principal food of the Filipino people.

A larger area is devoted to rice culture in the Philippines than to any other crop, and more people are engaged in the cultivation of rice than are employed in any other one industry. The present production of rice is by no means sufficient to meet the local demand, so that during the past seven years it has been necessary to import approximately ninety million pesos worth of this cereal from other countries.

The development of the Philippine rice industry to at least that point where the local production shall be sufficient to meet the local demand is one of the most vitally important industrial problems in this country. Climatic and soil conditions in the Philippines are eminently suited to rice culture. Large areas of uncultivated land are available for this crop, and the supply of work animals is increasing each year.

The two main factors in our rice problem are to extend the area now planted to rice, and to increase the yield per hectare. In view of the extremely low yield at the present time, and the comparatively small cost that would be entailed in increasing this yield, this factor may well be considered the more important of the two.

For a number of years the Bureau of Agriculture has been carrying on several lines of investigational work with rice for the purpose of obtaining as complete and accurate data as possible regarding this important crop. A large number of varieties of both lowland and upland rice have been tested under varying conditions and in different localities. As a result of these tests a few superior varieties have been selected, and these varieties are now being grown for seed production.

It is essential that we determine not only the varieties which can be grown to the best advantage in each province of the Islands, but also the cultural methods, the use of which will result in the largest possible yields. When it is considered

that an increase of but 1 cavan per hectare would mean an increase of more than 1,000,000 cavans in our annual rice crop, the importance of determining how such increase can be made is apparent.

THE PHILIPPINE LIVE-STOCK INDUSTRY.

During the past year the Philippine Islands imported more than 6 million pesos worth of live cattle, meat, and dairy products. During the same period more than 13 million pesos worth of rice were imported, largely because of the shortage of work animals with which to cultivate the rice fields of the Islands.

There exists at all times a demand both for work animals and for beef cattle at prices which make the production of live stock one of the most profitable industries in the Islands. There are available, also, large areas of as good grazing land as can be found in any part of the world.

Several decades ago, before the introduction of rinderpest, the supply of cattle and carabaos in the Islands was more than sufficient to meet the local demand. The rapid spread of this disease throughout the Islands resulted in the death of enormous numbers of animals, and up to the present time the agricultural interests of the country have only partially recovered from this disaster.

During the past five years rinderpest outbreaks have occurred in many parts of the Islands, and at the present time 12 provinces are known to be infected with this disease. It is a matter of record, however, that the total number of animals that have died from rinderpest during recent years is extremely small when compared with the total animal population of the country. It has been demonstrated that rinderpest outbreaks can be promptly and effectively controlled by quarantine measures, and that both cattle and carabaos can be immunized against this disease. It is known that the Indian cattle, now being imported into the Philippines, are highly resistant if not entirely immune to rinderpest.

Under these conditions the stockman in the Philippine Islands who uses judgment in selecting the location of his ranch, who exercises care in the selection of his breeding stock, and who takes reasonable precautions to prevent either the introduction or the spread of disease, need have but little fear of losses from rinderpest. On the other hand, he has highly favorable conditions for the production of live stock, and the assurance of a good market.

REGULATIONS GOVERNING THE EXPORT SHIPMENT FROM THE PHILIPPINE ISLANDS OF ALL PLANTS AND THE MATERIALS USED IN THE PACKING THEREOF.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS,
DEPARTMENT OF PUBLIC INSTRUCTION,
BUREAU OF AGRICULTURE.

MANILA, *March 3, 1916.*

GENERAL ORDER
No. 49.

Under authority conferred by section 2 of Act No. 2515, General Order No. 43 of the Bureau of Agriculture, governing the export shipment from the Philippine Islands of all plants and materials used in the packing thereof, is hereby amended, effective March 15, 1916, to read as follows:

SECTION 1. For the purpose of these regulations the terms herein used are defined as follows:

(*a*) "Plant material" shall include nursery stock, trees, shrubs, seeds, herbaceous stock, vines, cuttings, grafts, scions, bulbs, buds, and fruit pits, but shall not include fruits or vegetables designed for food purposes, or property dried and poisoned botanical specimens when so described over the signature and address of the sender on the face of the package.

(*b*) "Exporter" shall include the owner, consignee, and their agents.

(*c*) "Disinfection" shall mean any treatment applied for the purpose of destroying any infection or infestation that may occur on or amongst plant material subject to these regulations.

(*d*) "Plant inspector" shall mean any person so designated by the Director of Agriculture.

SEC. 2. All export shipments of plant material made from the Philippine Islands shall be accompanied by an accredited certificate of inspection as hereinafter provided.

SEC. 3. All export shipments of plant material shall be inspected by a plant inspector prior to forwarding. If said plant material is found to be free from pests and diseases, the plant

inspectors shall issue an accredited certificate of inspection stating such fact. If any pest or disease considered by the plant inspector to be of a dangerous character is discovered, the material shall be refused certification unless, in the opinion of the inspector, such material can be freed from said pest or disease by disinfection, in which case the exporter of the plant material in question shall be required to submit it to a process of disinfection. Such material shall then receive an accredited certificate of inspection stating the character of the pest or disease noted and the steps which have been taken to destroy said pest or disease.

SEC. 4. The process of disinfection shall be carried out in such manner an under such conditions as the Director of Agriculture may consider adequate for the destruction of such pests or diseases as may exist on or amongst said plant material.

SEC. 5. Suitable apparatus for the disinfection of plant material will be provided by the Bureau of Agriculture.

SEC. 6. All plant material intended for shipment out of the Philippine Islands shall be delivered at the office of an inspector at least forty-eight (48) hours before sailing date, and said material together with packing or packages pertaining thereto shall be removed from the place of inspection or disinfection within twenty-four (24) hours after receipt of written notification from the Director of Agriculture or his authorized agent requesting such removal. If removal is not made as herein provided said material may be destroyed or otherwise disposed of at the discretion of the Director of Agriculture. The said material shall be accompanied by a statement showing the name and address each of the shipper, ultimate consignee and importing agent, the locality where the material was grown or collected, and the nature of the material by name. If the material is not packed for shipment, indication should be made of the number of packages to be made and the amounts to be included in each.

SEC. 7. The cost of moving plant material to and from the place of disinfection shall be borne by the exporter of said material, and the Government may recover from the exporter an amount sufficient to cover any expenses incurred in connection with the disinfection, care, or storage of said material.

SEC. 8. The Government shall not be liable for any damage to plant material, or to packing and packages pertaining thereto, occasioned by disinfection.

SEC. 9. All shipments of plant material designed for export from the Philippine Islands shall be delivered, for inspection,

at the central office of the Bureau of Agriculture, Manila, and if certified shall be forwarded through the port of Manila, except that the Director of Agriculture may authorize inspection at and shipment from other points in the Philippine Islands in cases of special merit, provided that all additional expense incident to inspection outside the city of Manila shall be borne by the exporter.

SEC. 10. Any person or persons who shall fail to comply with the requirements of this order shall be liable to the penalties provided in Section 4 of Act No. 2515.

H. T. EDWARDS,
Director of Agriculture.

Approved:
H. S. MARTIN,
Secretary of Public Instruction.

THE AGRICULTURAL SITUATION IN THE PHILIPPINE ISLANDS.

By H. T. EDWARDS, *Director of Agriculture.*

The relative position of agriculture in the Philippine Islands in comparison with other industries is very clearly indicated by the nature of the export trade of the Islands. During the year 1915 the total value of Philippine exports amounted to ₱107,626,000, and of this amount ₱101,626,294 was received for the unmanufactured products of the farm. In view of this situation it is evident that the economic condition of the Philippines is largely determined by the degree of prosperity of its agriculture.

With a climate of perpetual summer, with vast areas of undeveloped fertile land, and with staple crops that are in demand throughout the civilized world, it appears that the Philippine Islands should be a rich and a prosperous country.

It does not necessarily follow, however, that in a country possessing an enormous wealth of natural resources there must be a correspondingly enormous and rapid development of these resources. The degree of progress in agriculture depends not only on natural conditions and resources, but also on certain vitally important economic factors.

In the Philippine Islands economic conditions have been such during the past ten years that industrial development has not been as rapid as it has been in certain other countries. As a result statements are occasionally made that there has been no improvement in the agricultural situation in the Philippines.

As a matter of fact a comparison of our agricultural situation today with the situation existing ten years ago clearly shows that there has been not only progress, but a remarkable degree of progress when we take into account the existing conditions. The purpose of this article is to describe briefly the more important lines of development in Philippine agriculture during the past decade, and also to show in what measure this development is being promoted by the work of the Government.

The degree of progress in the development of agriculture in any country is determined mainly by two things: First, the natural resources of the country in question; and, second, the qualifications and resources of the farmers. It may be of interest to note the existing situation in these Islands with respect to these two factors.

The Philippines unquestionally possess enormous agricultural wealth, and this country has very large areas of undeveloped, fertile land. It should be considered, however, that by far the larger part of the farm lands actually under cultivation have been cropped for generations with but little rotation of crops and practically no use of fertilizers. As a result these lands do not possess an extraordinary degree of fertility. Production on these lands can be increased, and is being increased, by the use of improved methods, but such progress must necessarily be slow. The cultivation of the more fertile and as yet undeveloped areas requires an amount of capital which the great majority of our farmers do not possess.

It is difficult to make any general statements respecting the qualifications and resources of the farmers of the Philippine Islands, because of the wide variation which exists. We have a small class of farmers who are familiar with modern methods of agriculture, and who are financially able to use such methods on their farms. We have a much larger number, however, who must gradually be shown the value of new methods, and who are not prepared, at present, to utilize such methods when they require any considerable expenditure of money. With this class of farmers progress has been slow in the past and will continue to be slow in the future.

According to the latest statistics available, 50 per cent of the farmers in the Philippine Islands cultivate each year less than one hectare of land, 89 per cent cultivate less than five hectares, and but three-tenths of 1 per cent cultivate more than 100 hectares. In other words, out of more than 800,000 farmers we have less than 2,500 who are operating what may be considerd large farms.

The small farmer is conservative in all countries of the world, and he is particularly conservative in oriental countries where he has not had the opportunity of becoming fully acquainted with the results obtained by the use of modern methods. There is a great work to be done with the small farmers of the Philippine Islands, but it is a work in which rapid progress must not be expected.

Turning to what may be considered our large farmers, we

find that even among this limited class there is lack of necessary capital to effect any large amount of development. This is not universally true, but the number of farmers in the Philippine Islands who have an abundance of capital is extremely small.

There remains to consider the development of our agriculture by outside capital, and, up to the present time, the amount of foreign capital invested in Philippine agriculture has been comparatively small. Such investments as have been made have been principally in the sugar industry, and have been made largely within the last three years.

There are two other factors which should not be overlooked in any consideration of our agricultural situation—these are labor and climatic conditions. The production of abacá during the last ten years shows little or no increase, largely because of the fact that the supply of labor available in the abacá districts does not justify any considerable increase in area planted. The development of our rice, coconut, abacá, and tobacco industries has been seriously retarded as a result of destructive typhoons, droughts, and floods.

Bearing in mind the above-mentioned conditions pertaining to agricultural development in the Islands, it may be of interest to consider briefly what progress has been made in our more important lines of agriculture during the ten-year period from 1905 to 1914. This period is taken for the reason that complete data regarding production and exports for 1915 are not yet available.

Rice industry.—There are a number of different factors which determine in a large measure the condition of the rice industry in these Islands, the most important of which are water supply, work animals and labor, and variety and quality of seed.

At the present time a large part of our rice is grown without artificial irrigation, and until such time as irrigation works are more generally developed the quantity of lowland rice produced annually in the Philippines will depend in a considerable degree on whether or not weather conditions are favorable.

During the past five years the number of carabaos available for work in the rice fields has increased each year. During the same period, and particularly during the last two years, the use of selected seed of the best varieties of rice has been much more general than formerly. That these factors are having an appreciable affect on the status of the rice industry is clearly shown both by our rice imports and by production.

In 1905 we imported ₱13,491,950 worth of rice. From 1906

to 1911 the value of the importations of rice ranged each year from 8 to 13 million pesos. The total value of rice imports for the two years of 1913 and 1914 was ₱12,881,478. In 1912, however, and again in 1915, on account of crop failures due to drought, there was a large increase in rice importation.

In order to show what has been the normal increase in production of rice, it is necessary to select two years in which weather conditions were fairly normal. In 1906 we produced 17,394,016 cavans [a] of palay, and in 1913, 24,498,858 cavans, an increase of 7,104,842 cavans, or 40 per cent, in a period of five years. During this same period the average production per hectare increased from 15.05 cavans per hectare to 21.47 cavans per hectare, an increase of 42 per cent.

The steady reduction in the annual loss of work animals from rinderpest, and the steady increase in the number of rice growers who are planting selected seed are improving the condition of the rice industry each year. We cannot be assured, however, of an annual rice crop that will be sufficient to meet the local demand until our irrigation works are more fully developed than they are at the present time.

Corn industry.—Corn is second only in importance to rice in the food crops of this country. With respect to area cultivated it is the crop of third importance in the Philippine Islands. Special attention has been given by the Bureau of Agriculture during the past five years to the development of the corn industry. Selected seed corn has been distributed throughout the Islands, coöperative corn demonstrations have been carried on in all of the principal corn-producing districts, and the field agents of the Bureau have made every effort to encourage the production of more and better corn. The throughly organized and well-managed "corn campaign" of the Bureau of Education has also been most effective in promoting the development of this industry. The results of the work of these two bureaus are shown by the following table:

Fiscal year—	Area cultivated.	Amount of shelled corn produced.	Average production per hectare.
	Hectares.	*Cavans.*[a]	*Cavans.*
1910	288,268	2,467,574	8.56
1911	302,516	2,485,396	8.22
1912	340,196	3,666,199	10.78
1913	383,709	4,339,339	11.31
1914	421,309	6,266,148	14.87

[a] One cavan equals 46 kilos, or 75 liters.

Within a period of five years the area devoted to corn has been increased by 133,041 hectares. The total production of corn has increased in the amount of 3,798,574 cavans, which represents an increase of 154 per cent. The average production of corn per hectare has increased from 8.56 cavans to 14.87 cavans, or 73 per cent.

In view of the fact that corn is now much more generally used in these Islands for human consumption than it was formerly, the steady development of this industry has a most important bearing on our food problem.

Coconut industry.—The rapid development of our coconut industry, which was more than three hundred per cent within a period of eight years, is most clearly shown by the value of coconut products (copra, copra cake, and coconut oil) exported. The value of coconut products exported in 1905 was ₱6,797,906, whereas in 1912 it was ₱28,367,012. Owing to destructive typhoons, followed by the outbreak of the European war, both production and prices of copra were considerably reduced in 1913 and 1914. The value of coconut products exported in 191~~2~~4 was ₱21,432,530, an increase, under unfavorable conditions, of ₱14,634,624 over 1905.

There is a large increase each year in the area devoted to coconuts, reports showing that more than four million trees were planted during the year of 1914.

The grave danger to this industry from coconut budrot has been largely eliminated by the system of Government inspection of coconut groves in infected districts. Under this system 1,335,412 trees were inspected, and 568 infected trees were destroyed during 1915.

The increasing production of coconut oil in this country, and the attention that is now being given to improved methods of drying copra will both serve to stimulate this industry.

Considering the fact that but very little foreign capital has been invested in coconut planting, the development of our coconut industry during the past ten years can hardly be considered other than satisfactory, and there is every indication that there will be even more rapid development during the next decade.

Sugar industry.—The development of the Philippine sugar industry during the past ten years, as indicated by value of exports of sugar, has been slightly over 100 per cent. The value of our sugar exports for 1905 was ₱10,146,466, while for 1914 it was ₱22,119,196.

This is the one agricultural industry in the Islands which has attracted the investment of a considerable amount of foreign

capital. As the investment of the major part of this capital has been made within the last three years, the results were only beginning to show in 1914. The actual development of our sugar industry is only partially indicated, therefore, by the above-mentioned export figures.

The one vital need of the Philippine sugar planters has been, and is to-day, improved milling facilities. Not only has enormous waste and loss of sugar resulted from the use of antiquated methods of milling, but the growing of the large, improved varieties of cane has been impracticable as these varieties cannot be handled to advantage in the small mills.

During the past three years the Philippine sugar planters have had an opportunity to learn the value of modern methods of milling. With the actual establishment of several large, modern centrals and the proposed construction of others, our sugar industry appears to be entering a period of prosperity.

Tobacco industry.—The exports of Philippine tobacco and tobacco products in 1905 were valued at ₱4,563,406; in 1912, ₱10,726,764; and in 1914, ₱8,355,064. The production of tobacco in 1914 was seriously curtailed by unfavorable weather conditions, but, even under these conditions, the exports show nearly 100 per cent increase over the exports of 1905.

The tobacco industry, while showing a reasonable degree of development, is not in a satisfactory condition, and the situation is one that is extremely difficult to regulate. The majority of the tobacco producers are small planters who cultivate not more than 1 or 2 hectares of land. They are without capital and have become accustomed, through long practice, to receiving advancements on their crops from tobacco buyers and middlemen. The tobacco crop is sold in large part according to quantity without respect to quality, and, under these conditions, there is but little inducement for the growers to improve their crop.

During the past two years selected and cleaned tobacco seed has been distributed throughout the principal tobacco-growing districts, and the planters have been instructed regarding the preparation of seed beds, the care of the crop, and the handling of the product. This work has resulted in improvement, but until there is a radical change in the economic situation in the tobacco districts this important industry will not develop as rapidly as it otherwise would.

Abacá (manila hemp) industry.—The value of abacá exported in 1905 was ₱43,514,688; in 1912, ₱45,873,712; and in 1914, ₱39,531,204. The production in 1914 was affected by unfavorable weather conditions, and the market by the European war.

At the close of 1914, however, the abacá industry was on practically the same footing that it was ten years earlier, at the close of 1905.

That there has been little, or no, increase in production is largely due to the fact that practically all of the fiber produced is cleaned by a slow hand-stripping process, and the supply of labor in the abacá districts has not been such as to justify increased planting. Up to the present time no abacá-cleaning machine has been devised that has met the requirements of the planters, and until such a machine becomes available, or there is a material increase in the labor supply, any large increase in the production of abacá cannot be expected.

The most important factor in the abacá situation has been the establishment during the past year of a system of Government grading and inspection. This system was necessitated by the increasing dissatisfaction of manufacturers both in the United States and Great Britain with abacá fiber.

Maguey industry.—The enactment of the fiber inspection law has also had an extremely important effect on the Philippine maguey industry. The exports of this product slowly increased each year from ₱343,626 in 1905 to ₱834,114 in 1914. In 1915 ₱1,070,407 the exports of maguey amounted to [redacted], with prospects of a still further increase during the present year.

Live stock.—While there is a great deal of comment on the subject of animal diseases in the Philippine Islands, the importance of our livestock industry and the rate of development of this industry are subjects which are not generally understood. The increase in value of the domestic animals in the Philippine Islands, based solely on the increase in number, was approximately fifty million pesos for the four-year period, 1910 to 1914, as shown by the following table:

Live stock in the Philippine Islands.

	Dec. 31—		Increase.	Value of increase.
	1910	1914		
Carabaos	756,724	1,147,433	390,709	₱27,349,630
Cattle	269,963	477,736	207,773	10,388,650
Horses	142,604	215,826	73,222	5,125,540
Hogs	1,681,550	2,285,880	604,330	4,834,640
Goats	441,455	592,042	150,587	376,467
Sheep	94,166	118,010	23,844	71,532

The protection of the health of the domestic animals of the Islands has been given first consideration during the past ten

years in the work carried on by the Government for the promotion of agriculture. The above-mentioned figures are sufficient to indicate why this work has been considered of such vital importance.

GOVERNMENT WORK IN AGRICULTURE.

The major part of the work carried on by the Philippine Government to promote the development of agriculture has been along the four following lines: *Investigation,* which includes both laboratory and field investigations; *protective,* which has to do with the control of diseases and pests of domestic animals and cultivated crops; *public services,* which cover such work as the distribution of selected seeds and plants, the production and distribution of improved breeding animals, and the standardizing of staple crops; and *educational,* which includes the various lines of work pertaining to the dissemination of useful information regarding Philippine agriculture.

INVESTIGATION.

The major part of the investigational work of the Philippine Government has been carried on by the Bureau of Science. The Bureau of Agriculture, however, has had for a number of years a veterinary research laboratory, and has maintained experiment stations and farms, both in Manila and in the provinces.

PROTECTIVE SERVICE.

Conditions in these Islands have been such that the first and most important work of the Government in its relation to agriculture has been the protection of domestic animals from disease, and the protection of cultivated crops from disease and pests. For a period of nine years from 50 to 75 per cent of the total appropriation for agricultural work was devoted to the rinderpest campaign.

Rinderpest campaign.—It is impossible to accurately estimate what the loss of human life from disease would have been in the Philippine Islands had there been no public health service, or what the losses from fire would have been in the City of Manila without a fire department. It is equally impossible to estimate what the annual losses would now be from rinderpest if there were no protective veterinary service.

We do know, however, that in the one year of 1902, before a protective veterinary service was in operation, there were reported 629,176 deaths of cattle and carabaos, mainly from rinderpest. The value of these animals was approximately 45 million pesos, and the losses sustained in this one year from

rinderpest alone would be sufficient to maintain, at the present rate of expenditure, a veterinary protective service for two hundred and twenty-five years.

The number of reported deaths of cattle and carabaos from rinderpest for the year 1915 was 2,305. The approximate value of these animals was 166 thousand pesos.

The estimated number of cattle and carabaos in the Philippine Islands in 1915 was 1,930,000, having an approximate value of 140 million pesos. It may be noted, therefore, that the total losses last year from rinderpest amounted to slightly over one-tenth of 1 per cent of the total value of our cattle and carabaos. It may be noted, also, that the total cost of our veterinary protective service, which was approximately 200 thousand pesos, was less than fifteen-hundredths of 1 per cent of the total value of the animals protected.

It is most unfortunate that statements have been made from time to time predicting the complete eradication of rinderpest in these Islands in the very near future. These statements have resulted in a general understanding that the complete eradication of rinderpest was the one essential function of the veterinary service, and that until this result was accomplished the veterinary work might properly be considered a failure.

As a matter of fact the complete eradication of rinderpest in these Islands at any time in the near future, while a possibility, is most improbable. The infection is widespread and is carried not only by domesticated cattle, carabaos, hogs, goats, and sheep, but also by wild carabaos, wild hogs, and deer. The country is almost entirely unfenced, and many animals which contract rinderpest and are capable of spreading the infection have the disease in such a mild form that it is almost unrecognizable.

In view of these conditions it is to be expected that we shall continue to have rinderpest for many years to come, and it is imperative that we should continue to provide an efficient protective veterinary service. With an efficient quarantine system, in which there is coöperation of local officials and the owners of live stock, and with the gradual extension of immunizing in the badly infected centers, the danger from rinderpest is reduced to a minimum.

The degree of efficiency of the veterinary protective service that has been maintained by the Government up to the present time can best be measured by the amount of protection that has been furnished. The death rate of cattle and carabaos from rinderpest has been steadily reduced from year to year, until it

has reached a point of approximately one-tenth of 1 per cent. The continued maintenance of an efficient veterinary service should result in a still further reduction, with the probability of the ultimate complete eradication of the disease.

Locust campaign.—For a number of years the Philippine Islands have been infested with enormous swarms of locusts. nearly every province having suffered from this pest. The control of the locusts has required the organization of a special branch of the protective service to handle this work. Local officials throughout the Islands have been furnished assistance, equipment for fighting the locusts has been widely distributed, and trained locust inspectors have been detailed to supervise the campaign in badly infested districts.

During the year 1915, 30 different provinces were furnished allotments of funds and equipment for fighting locusts in a total amount of ₱49,112.

It is just as impossible to estimate what the losses to the farmers of these Islands would have been during the past year from locusts, without a thoroughly organized locust campaign, as it is to estimate what the losses would have been from rinderpest if there were no veterinary protective service. It is only reasonable to assume, however, that an organized campaign supervised by trained and experienced men is more effective than a campaign carried on without organization or supervision.

There is no probability that locusts will be entirely eradicated from the Philippine Islands at any time in the near future. There is no reason, however, why this pest cannot be kept under control and prevented from doing serious damage if there is maintained at all times a small force of trained locust inspectors, and an efficient field organization.

Coconut budrot campaign.—Early in 1915 it was ascertained that coconut budrot was spreading in our most important coconut districts, and that our coconut industry was threatened by this extremely dangerous disease. A force of men was detailed on this work and from April to December, 1915, 1,335,412 trees were inspected and 568 infected trees destroyed. It appears that this disease is now under control, but continued inspection of coconut groves will be necessary for as long a time as there is any coconut budrot in the Islands.

Miscellaneous diseases and pests.—There are numerous diseases and pests in these Islands affecting both plants and animals. Rinderpest, locusts and budrot have been the most serious during the past year, but others equally serious are liable

to develop at any time. The only way to effectively check and control these pests and diseases is the maintenance of an efficient protective service by the Insular Government.

PUBLIC SERVICES.

Seed and plant distribution.—During the year 1915 the Bureau of Agriculture distributed, principally through its field agents, 47 tons of selected seeds, and 80 thousand plants. A large part of these seeds and plants were produced at the stations of the Bureau, and the material distributed has been principally selected varieties of our staple crops. Where the opportunities for obtaining seeds and plants are as limited as they are in these Islands a well-regulated and carefully supervised system of Government seed and plant distribution is an important factor in promoting agricutural development.

Public live-stock breeding.—At the close of the year 1915 the Bureau of Agriculture was maintaining breeding animals for public service at 39 different points in 17 different provinces. The animals used for this public breeding work included 26 stallions, 17 bulls, 37 boars, and 5 billies. In addition to these animals maintained by the Government for public breeding, 485 head, largely breeding animals, were sold to the public from the Bureau farms during the year.

That the work carried on by the Government to promote the development of the live-stock industry, by means of the production and distribution in the provinces of breeding animals, is producing results has been fully demonstrated. The demand for good breeding stock is steadily growing, and a special effort is being made to meet this demand.

Fiber inspection.—During the latter part of 1914 the Bureau of Agriculture organized a system of fiber grading and inspection, which became effective on January 1, 1915. For a long period of years the complaints received from both American and British manufacturers regarding Manila fiber had continued to grow more numerous and bitter. It was clearly apparent that other fibers were gradually being substituted for abacá, and that it was only a question of time when the market for abacá would be seriously affected if not entirely ruined. The fiber-grading and inspection system of the Philippine Government was organized to meet this situation.

This system has now been in operation one year, during which time all fiber exported has been graded under the Government grading system, and has been inspected by Government

inspectors. It is not claimed that this system is, as yet, by any means perfect. That it has already resulted, however, in a marked improvement in the condition of our fiber industry is indicated by the following statement recently made by the secretary of the British Rope Manufacturers' Association:

> The experience of British rope manufacturers of the scheme of grading set up by your Department under the Act goes to show that it is a decided improvement upon the conditions obtaining previous to the passing of the Act, quality having greatly improved and there being less trouble and more satisfaction in the actual buying and selling.
>
> I inclose original letters received from 25 British rope manufacturers testifying to the value of the Government scheme and strongly protesting against any efforts being made for the repeal of the Act. The letters comprise all the manufacturers of any importance in the British Isles and it is submitted that the opinion of these firms which you will observe is unanimously in favour of the new Act, should receive special weight seeing that they are the actual users of the manila hemp.

One feature of the fiber-inspection work is that it is entirely self-supporting and yields a small revenue to the Government.

Food-production campaign.—Immediately following the outbreak of the European war, in August, 1914, it became apparent that there might be interruption in the importation of food products into the Philippine Islands, particularly from French Indo-China and Australia. In order to provide for any shortage in food that might occur, the Bureau of Agriculture organized a so-called "food-production campaign." Approximately 60 of the field employees of the Bureau have devoted part of their time to this campaign during the past sixteen months, and the results have been such that it has been made a permanent feature of the Bureau's work.

The purpose of the food-production campaign is to encourage the increased planting of all food crops, particularly such secondary crops as sweet potatoes, beans, and garden vegetables. The support of local officials in the provinces has been enlisted, and both the officials and the farmers have responded in a gratifying manner. It is impossible in a work of this kind to keep a complete or a close check on results obtained. Records are at hand, however, which show that there has been a widespread increase in the planting of secondary food crops, and that in certain districts this campaign has been the means of saving the people from a serious shortage of food.

The more general production of miscellaneous food crops will not only increase our local food supply, thereby reducing the importations of rice, but will also materially improve the quality of our food supply.

EDUCATIONAL.

Coöperative demonstration work.—For a period of ten years the means used for the dissemination among the farmers of these Islands of information regarding improved methods of agriculture were largely confined to the distribution of printed matter, and occasional lectures. In 1912 an office of coöperative demonstration work was organized in the Bureau of Agriculture. During the year 1915 sixty field inspectors have been employed in this work.

The essential purpose of the coöperative demonstration work is to show the farmers on their own farms in a simple and practical way the value of improved methods. Selected seeds are furnished, and modern implements are loaned to coöperators. The Government inspectors supervise the planting and cultivation of the coöperative plots, and assist the farmers in every way possible.

During the past year this work has been carried on with nearly four thousand coöperators in 22 different provinces. Thousands of packages of seeds and plants have been distributed and planted under the direct supervision of the Bureau agents, and approximately 600 lectures have been given by Bureau agents at meetings held by the farmers.

Coöperative organization.—In 1914 a movement was started to organize in each province and municipality a coöperative agricultural society. At the close of the year 1915 these societies had been organized in 29 provinces and in 295 municipalities.

One of the strongest factors contributing to the development of agriculture in the most progressive countries of the world during the past ten years has been coöperation on the part of the farmers. The almost entire lack of effective coöperation among the farmers of these Islands is one of the most serious defects in our agricultural situation.

The building up of any general system of agricultural coöperation in the Philippine Islands will be a work of many years. The foundation for such a system is an understanding on the part of the farmers of the value of coöperation, and a desire for coöperative effort.

The main purpose of the agricultural societies is to bring the farmers of the country together in an organization through which the idea of coöperative effort may gradually be disseminated.

Each member of these societies is furnished with a monthly farm paper, and every society is furnished a weekly market

report. Many of the societies have already perfected organizations that are a strong force in their respective communities.

CONCLUSION.

The degree of progress in the development of agriculture in these Islands in the immediate future will be largely determined by the amount of capital invested in our agricultural industries, and by the amount of money appropriated by the Philippine Government for the promotion of agriculture.

During the past ten years the investments of capital have been small and Government appropriations have been limited. As a result progress has been slow. That there has been progress, however, and a marked degree of progress, is clearly demonstrated by existing facts.

Inasmuch as agriculture is the one vitally important industry in these Islands—the one industry which will determine in a very large measure the entire future of this country—it would appear that no effort should be spared to promote the interests of this industry.

CORRELATIVE CHARACTERS OF THE RICE PLANT.[1]

By H. O. JACOBSON, *Chief, Plant Industry Division.*

In a region such as the Philippine Islands, where there is an unusual multiplicity of varieties of the most important cereal, it is necessary to know something about the relative values of the most apparent characters, especially in their relation to two habits, namely, the period required by a variety in which it can reproduce itself and the degree of reproduction.

The yield is, of course, paramount, but as has been shown in another paper,[2] the maturing period determines to a great extent the practicability of cultivating a variety under the most prevalent conditions, which is without irrigation and with dependance on rainfall only for water supply.

In the beginning the main feature of the investigational work was to become acquainted with the many varieties most commonly cultivated, and in the treatment of the several hundred varieties, a mass of data accumulated which we have utilized in the preparation of the tables appearing in this article. Had it been originally intended to produce material for such a study for which the data have later been utilized, many changes in and additions to the scheme followed would have been effected. Certain measurements are rather coarse for the construction of some of the tables, and some of the minor characters have been omitted from observation and record.

As is quite natural, the most prominent characters, such as straw length, number of grains per panicle, etc., have been considered first but such characters appear to be too markedly affected by environmental conditions, hence lack both stability and dependability as such for guides to the determination of their probable values in relation to other characters.

[1] Acknowledgment is due Dr. W. H. Brown, University of the Philippines, for the interest he has taken in this paper and for valuable suggestions in the preparation thereof.

[2] The Causes of Low Yields of Rice in the Philippines, Philippine Agricultural Review, vol. 8 (1915), No. 4.

Careful analysis is not required in order to present the probability that correlation studies may represent the results due to physiological forces rather than to heredity, when characters regarded as being morphological are considered. On the other hand, morphological characters, known to be transmitted in some given degree, if associated with the desired habits, in a corresponding degree, are the principal ones with which we must work and attempt to derive our proof. The study must necessarily be pushed to such a point that the effects of environment can be recognized with reasonable accuracy and discounted.

As will be shown later straw length as a character may bear a very positive relation to period of maturity in a given season, because of yery favorable meteorological conditions throughout the entire growth period so that optimum development is attained, whereas, in the succeeding season, less favorable conditions may seriously check the straw growth and yet the effect on the maturing period be so nominal that the relationship may appear to be negative. In this case the environmental forces must be carefully valued. But, if on the same point another sort of character, such as the number of nodes, is found to bear a marked relation to maturing period, one can determine the value of the plant under consideration in this respect with reasonable accuracy under rather widely differing conditions.

For the purpose of ascertaining correlation values, the sort of characters not affected or but little influenced by environment are of greater value to the plant breeder than others. However, it is among the more variable characters that we will find the largest number of subjects and it is of importance to determine their association and correlative value.

We have learned of the discovery of stable minute or microscopic characters, and their usefulness in selection work, examples of which the Svalöff Plant Breeding Station has given to the public, and our experience has tended to incline us to decreasingly value the more fluctuating characters such as those of dimension and weight.

We have come to the point now, in our work with rice, where we feel certain that much closer study of the individuals must be made with the view of recognizing these smaller characters and the nature of their associations.

In the tables we have prepared the data are such as we have taken on varieties of the usual composition—that is to say, mass selections, composed oftentimes of a number of apparent "elementary species." As the plot testing of varieties progressed

a certain increase in uniformity in the composition of these was effected by the removal of obvious admixtures. In general these so-called varieties were sufficiently uniform to be easily recognized as such, many of them having been recognized by given names from unknown though distant dates. It will be noticed that the number of varieties varies from year to year, due to the addition of new ones and the elimination of others, but the mean of the subject or the relative does not vary on that account as much as might be anticipated.

When the data on pedigree cultures, or as Johannsen terms them, pure lines, become available we shall have somewhat more reliable figures for correlation values. Meanwhile, we shall see what seems to be the tendency of the characters to associate with others as found in these so-called varieties.

Each correlation is shown for the years 1909, 1910, 1911, 1912, and 1913, and a composite table of the five years is appended. The composite table alone is not deemed sufficient since it does not reveal the variation year by year. Wherever it has appeared to be essential other tabulations termed association assemblies are appended to further illustrate the subject treated.

A number of characters have been considered with regard to their association with yield, and again with relation to maturing period. A few characters have been studied in regard to their relation to other characters which are related to one or the other of these more important ones. The correlation tables throughout have been prepared by Franklin A. Coffman, station superintendent in the plant industry division. In the tables which are submitted the value of each unit or each occurrence should be explained.

The yield is based on the average return obtained from 960 to 1,440 plants grown on four to six differently located plots, single seedlings to the hill, each hill occupying 625 square centimeters. In other instances the unit figure represents the average of an equally large number, consequently the total number of occurrences entering into the tabulations represents an immensely greater population than is indicated by the figures in the tables.

One of the most common beliefs is that the late-maturing varieties of rice are the highest yielders. It is argued that with a given leaf area, a given number of hours of sunshine, etc., only a given amount of starch can be produced to be deposited in the kernels, hence it is presumed that early-maturing sorts possess this habit at the expense of yield.

The time period required by any given variety to mature varies slightly from season to season depending mostly on the growth conditions provided. Yield, on the other hand, fluctuates very considerably, and is affected by a number of influences.

In the following tables the time period—days to maturity as the subject—is considered with yield expressed in terms of quintals of 100 kilograms each, as the relative:

Correlation of days to maturity and yield of grain.

TABLE No. 1.—1909.

Days.	Quintals per hectare.													Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	
	Occurrences.													
120		1							1	1		1		4
130			1			1	1			1	1	1		6
140						1		1		1	2			5
150			1	1	3	2	5		4	2				18
160			1		3	2	7	2	2	1		1		19
170			3			7	6	5	2	4	2	1	1	31
180	2			2	5	2	3	1	3					18
190			3	4	5		1	1						14
200		2		2	2									6
210		1	1	3		1								6
Total	2	4	10	12	18	16	23	10	12	10	5	4	1	127

Mean number of days, 167.9.
Mean yield, quintals per hectare, 17.21.
Coefficient of correlation, -0.403 ± 0.058.

TABLE No. 2.—1910.

Days.	Quintals per hectare.															Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	
	Occurrences.															
120			1		2					1		1				5
130	1	1			2	1	4	2	3	2			1			17
140			1	3	1	3	4	7	2	2	3	1	1	1		29
150		2	1	1	1	4	3	3	4	4	1		1			25
160				1	3	6	5	12	9	4	5	1		1		47
170	1	1		1	3	4	12	9	5	3			1	1		41
180	1		3	2	3	6	6	6	4	5	3	1	1	1	1	43
190				1			3	3	3	3	2					15
200							1		5	2	2	2				12
210				1			1			1						3
Total	3	4	6	10	15	24	39	42	35	27	16	6	5	4	1	237

Mean number of days, 163.4.
Mean yield, quintals per hectare, 19.70.
Coefficient of correlation, -0.104 ± 0.0443.

Correlation of days to maturity and yield of grain—Continued.

TABLE No. 3.—1911.

Days.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
120																		
130	1		2	1	1	2	1											8
140	3	3	1	1	5	3	8	1	1		1				1			23
150	4	3	7	4	6	13	3	5	2									47
160	4	5	9	4	4	3	2	4	3	1	1	2						42
170	2	6	4	3	3		2	7	3	6	2	4			1	1	1	45
180	2	9	8	6	6	4	2		3									40
190	14	10	7	4	1	2												38
200	18	10	3															31
210	2																	2
Total	50	46	41	23	26	27	13	17	12	7	4	6			2	1	1	276

Mean number of days, 166.
Mean yield, quintals per hectare, 12.93.
Coefficient of correlation, —0.218±0.0388.

TABLE No. 4.—1912.

Days.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
120			1		1						1							3
130	2	5	5	4	4	3		2		4	2	5			1			37
140	1	2	2	5	6	2	2	1	5	2	4	5	4	1	2	1		45
150				1		1	4	2	1	2	4		3	1	1	1		21
160			1				1		2	1		3	1	2			1	12
170			1	1	1		1	1	2	3	1	1		2	1	1		16
180				3	4		2	4	7	8	2				1			31
190		1	2	1			2	1	1		1							9
200			1		1													2
210	2	1	1															4
Total	5	9	14	15	17	6	12	11	18	20	15	14	8	6	6	3	1	180

Mean number of days, 154.3.
Mean yield, quintals per hectare, 20.17.
Coefficient of correlation, —0.015±0.05.

TABLE No. 5.—1913.

Days.	Quintals per hectare.												Total.
	6	8	10	12	14	16	18	20	22	24	26	28	
	Occurrences.												
120				1	1		1	1					4
130			2	3	4	4	2						15
140		1	2	5	6	5	2	3					24
150				1		2	3	2	2		1		11
160					3		2	2	2		1		10
170		1		3	1	2	6	3	2	1	1	1	21
180				2	2	3	6	5	4	1	2		25
190				1	2	2	2	2	1	1			11
200	2					1							3
210		1											1
Total	2	3	4	16	19	19	24	18	11	3	5	1	125

Mean number of days, 160.
Mean yield, quintals per hectare, 16.81.
Coefficient for correlation, —0.143±0.0578.

Correlation of days to maturity and yield of grain—Continued.

TABLE No. 6.—1909-1913.

Days.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
120	----	1	2	1	4	----	1	1	1	2	1	2	----	----	----	----	----	16
130	4	6	10	8	11	11	8	4	3	7	3	6	1	----	1	----	----	83
140	4	6	6	14	18	14	11	13	8	5	10	6	5	2	3	1	----	126
150	4	5	9	8	10	22	18	12	13	8	6	----	4	1	1	1	----	122
160	4	5	11	5	13	11	17	20	18	7	7	7	1	3	----	----	1	130
170	3	8	8	8	8	13	27	25	14	17	6	7	2	3	2	2	1	154
180	5	9	11	15	20	15	19	16	21	14	7	1	1	1	2	----	----	157
190	14	11	12	11	8	4	8	7	5	4	3	----	----	----	----	----	----	87
200	20	12	4	2	3	1	1	----	5	2	2	2	----	----	----	----	----	54
210	4	3	2	4	----	1	1	----	----	1	----	----	----	----	----	----	----	16
Total	62	66	75	76	95	92	111	98	88	67	45	31	14	10	9	4	2	945

Mean number of days, 164.6.
Mean yield, quintals per hectare, 17.11.
Coefficient of correlation, -0.201 ± 0.021.

TABLE No. 7.—*Average number of days to maturity per variety and average yield of grain.*

[Association assembly.]

1909			1910			1911		
Occurrences.	Average days to maturity.	Average yield of rough rice per hectare.	Occurrences.	Average days to maturity.	Average yield of rough rice per hectare.	Occurrences.	Average days to maturity.	Average yield of rough rice per hectare.
		Kilos.			*Kilos.*			*Kilos.*
1	115	--------	1	110	2,587	9	135.8	1,268
4	125.3	2,174	6	127	1,689	24	146.6	1,580
9	135.2	2,040	16	133.9	1,908	48	153.8	1,428
9	145.2	2,295	31	144.3	2,084	40	164.8	1,490
20	154.5	1,888	26	153.2	1,964	48	173.9	1,867
23	166.2	1,788	46	164.8	2,161	41	184.3	1,297
39	174.8	2,025	42	174.0	1,997	44	194.2	898
18	183.2	1,669	46	185.2	2,089	47	207.3	582
13	191.9	1,508	15	193.9	2,133			
13	208.9	1,220	15	207.1	2,335			
1912			**1913**			**1909-1913**		
1	118	462	2	113.5	135	5	114	829
2	124.5	1,883	4	126.5	1,749	16	124.8	1,849
40	135.3	1,732	14	134.9	1,524	88	135	1,715
46	144.1	2,124	23	145.3	1,512	133	144.8	1,903
22	155.0	2,058	13	154.8	1,733	129	154	1,748
14	164.3	2,997	10	165.9	1,947	133	169	1,966
16	174.4	2,558	21	174.6	1,898	166	174.3	1,995
33	184.1	2,193	25	185.3	1,971	163	184.5	1,846
6	192.5	1,929	11	193.5	1,877	89	193.5	1,376
6	212.3	1,001	6	208.8	810	87	210.2	1,024

On page 87, Volume VI, of THE PHILIPPINE AGRICULTURAL REVIEW, C. M. Conner presents a chart showing 279 lowland varieties of rice grown in Indo-China in comparison with a like number of varieties grown in the Philippine Islands in which the grouping is arranged according to yield per hectare and days to maturity. It is stated that the average yield per hectare does not increase with the number of months to maturity, in fact, months to maturity bears no relation to the yield.

Reference to the preceding tables shows that for 1909 the varieties maturing within 180 days were well distributed according to yield, but those requiring a longer period are found only in the columns of lowest yield, the principal cause of the low yield being that the weather became hot and the days bright, which prevented complete normal maturing of the slow-growing sorts. Since 26 of the 127 varieties were of this class the mechanical effect of their position has thrown the correlation very much in one direction. The same situation prevailed in 1911, but the unfavorable growth conditions then affected all the varieties more or less so that the result is not so pronounced. The fact remains that the late-maturing varieties seldom are accorded a long enough period of high relative atmospheric humidity, etc., so that they develop normally as do the ones that mature earlier. In 1910, 1912, and 1913 the weather conditions were more favorable, consequently the figures for those years may be regarded with confidence, especially those for 1910.

The composite table yields a correlation coefficient that is negative, but this result is due, as intimated above, to the mechanical features of the tables, for which reason the tables for 1909 and 1911 should not be too seriously considered. It should be noted that the age period is not extended to the minimum, but does embrace the maximum. A three-month rice is a possibility but we are not yet acquainted with one which can be grown under usual lowland cultural methods which will actually mature in such a short period. Extra early maturity is nearly always secured at the expense of yield. On reference to the composite table it will be seen that none of the 120-day varieties have been recorded in the columns of very high yields but even so some of them have produced unusually well. Up to the point where varieties require more than 180 days to mature, one finds such a wide distribution with regard to yield that one class has little advantage over another. With those requiring

more time, knowing the behavior of many of them in the restricted areas where the rainfall is distributed over a much longer period than prevailed at the experiment stations, and with the greater number of rainy days per month with attendant relatively high atmospheric humidity, it is safe to say that they would have produced so much more grain that the yield figures would have as general a distribution as the somewhat earlier-maturing classes. Therefore we say that the days to maturity has a small positive correlation to yield within the limits defined provided as favorable growth conditions can be given the late-maturing varieties as is supplied the earlier ones. This relationship is so slight that there is no reason to suppose that a 120-day variety cannot be found which will be as productive as any 180-day variety grown under prevailing conditions. If the growth period is reduced to a shorter term than 120 days, our opinion is that such precocity will result unfavorably on yield, though we have not sufficient positive evidence to offer on that point as yet, to make the statement without qualification.

Reference to Tables Nos. 1 to 5, shows that the best of the early-maturing varieties did not yield as much as the best of the later-maturing sorts. Yet in most classes there were occurrences of equally good yield irrespective of age to maturity.

There appears to be a greater number of six-month varieties in culture here and elsewhere in tropical regions, than of any of the earlier or later classes. Some reasons for this are obvious while others are not apparent; reference to this subject will be made later.

In the valuation of any cereal variety emphasis is always placed on the degree of tillering habitually exercised by it. With rice which is transplanted, a deficiency in this habit can be offset to a great extent if not entirely by closer planting. Furthermore, considering the number of culms per plant, without regard to the number of grains per panicle, the size and density of the kernels, leaves out very important factors in the determination of the value of tillering. However, in the following data the seedlings have been planted singly in areas of 625 square centimeters each, and should therefore show high relation between the tillering habit and yield. Yield of rough rice is expressed in quintals of 100 kilograms each as the relative; the number of culms per plant as the subject.

Correlation of tillering and yield of grain.

TABLE NO. 8.—1909.

Culms per plant.	Quintals per hectare.													Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	
	Occurrences.													
3			1											1
4			1			1						1		3
5	1	3	3	2	8	3	6	1	1	2	1		1	32
6	1	1	4	7	8	10	17	9	9	5	1	1		73
7				1	1	1	2	1	2	1		1		10
8						1				1	2			4
9										1		1		2
10											2			2
11														
12									1					1
Total	2	4	9	10	17	16	25	11	13	10	6	4	1	128

Mean number of culms, 5.976.
Mean yield, quintals per hectare, 17.51.
Coefficient of correlation, 0.290±0.54.

TABLE NO. 9.—1910.

Culms per plant.	Quintals per hectare.															Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	
	Occurrences.															
3							1				1					2
4		1	1	4		3	4	2	1		2			1		19
5		3	4	5	4	7	16	13	12	12	7	3	3	2		91
6	2		1	1	3	10	7	14	10	10	3				1	62
7	1				2	3	5	7	6	4	3	2	2			35
8					3			2	1	1		1				8
9									1	1	1			1		4
10							1									1
Total	3	4	6	10	12	23	34	38	31	28	17	6	5	4	1	222

Mean number culms per plant, 5.69.
Mean yield, quintals per hectare, 19.88.
Coefficient of correlation, 0.144±0.044.

TABLE NO. 10.—1911.

Culms per plant.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
3	7	3	1		1				1	1								14
4	24	17	13	5	3	1		3	1									67
5	10	13	12	10	8	8	3	6	4	2	1				1			78
6	6	10	9	5	8	8	4	2	3	3	1	2	0	1	1		1	64
7	3	3	5	1	6	9	4	3	3	1	2	2				1		43
8	1			1	1	1	1		1			2						8
9				1														1
10			1															1
Total	51	46	41	23	27	27	12	14	13	7	4	6	0	1	2	1	1	276

Mean number culms per plant, 5.31.
Mean yield, quintals per hectare, 12.95.
Coefficient of correlation, 0.372±0.039.

Correlation of tillering and yield of grain—Continued.

TABLE No. 11.—1912.

Culms per plant.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
3	1	1	1															3
4	4	5	8	6	5			1	1									30
5	1	2	3	8	8	3	6	1	6	2		3	1					44
6					3	2	3	3	6	6	5	2	1	3		2		36
7						1	2	4	3	13	9	7	4	2	3			48
8								1	2	2		1	2	1	3	1	1	14
9									1		1	1						3
10											1							1
11											1							1
Total	6	8	12	14	16	6	12	10	18	23	17	14	8	6	6	3	1	180

Mean number culms per plant, 5.89.
Mean yield, quintals per hectare, 20.48.
Coefficient of correlation, 0.712±0.032.

TABLE No. 12.—1913.

Culms per plant.	Quintals per hectare.												Total.
	6	8	10	12	14	16	18	20	22	24	26	28	
	Occurrences.												
3	2	2	1	3	1	1	1	1			1		13
4		1		11	11	15	15	13	6	1	2		75
5			1		5	3	7	6	2	1	2		27
6							2			1		1	4
7						1							1
8				1									1
Total	2	3	2	15	17	20	25	20	8	3	5	1	121

Mean number culms per plant, 4.24.
Mean yield, quintals per hectare, 16.94.
Coefficient of correlation, 0.350±0.059.

TABLE No. 13.—1909-1913.

Culms per plant.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
3	10	6	4	3	2	1	2	1	1	1	2							33
4	28	24	23	26	19	20	20	19	8	1	4	1		1				194
5	12	21	23	25	33	24	38	27	25	19	11	6	5	2	1			272
6	9	11	14	13	22	30	33	28	28	25	10	6	1	4	2	2	1	239
7	4	3	5	2	9	15	13	15	14	19	14	12	6	2	3	1		137
8	1			2	4	2	1	3	4	4	2	4	2	1	3	1	1	35
9				1					2	2	2	2		1				10
10			1				1				3							5
11											1							1
12									1									1
Total	64	65	70	72	89	92	108	93	83	71	49	31	14	11	9	4	2	927

Mean number culms per plant, 5.47.
Mean yield, quintals per hectare, 17.23.
Coefficient of correlation, 0.419±0.018.

TABLE No. 14.—*Average number of culms per plant per variety and average yield of grain.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average culms per plant.	Average yield of rough rice per hectare.	Occurrences.	Average culms per plant.	Average yield of rough rice per hectare.	Occurrences.	Average culms per plant.	Average yield of rough rice per hectare.
		Kilos.			*Kilos.*			*Kilos.*
1	3.7	1,147	----	----	----	2	2.6	613
3	4.5	1,829	2	3.8	2,300	21	3.5	725
34	5.6	1,689	19	4.6	1,661	78	4.4	925
81	6.3	1,843	94	5.5	2,129	82	5.5	1,337
10	7.3	2,104	61	6.3	1,966	66	6.4	1,526
4	8.6	2,438	35	7.3	2,188	43	7.3	1,726
2	9.7	2,701	9	8.2	2,102	8	8.4	1,915
2	10.4	2,786	4	9.5	2,681	1	9.0	1,269
1	12.6	2,373	2	10.3	1,847	1	10.6	1,045
1912			**1913**			**1909-1913**		
3	3.7	904	1	2.8	456	3	2.7	561
30	4.6	1,136	17	3.6	1,197	44	3.6	1,007
47	5.4	1,757	78	4.3	1,760	208	4.4	1,342
37	6.5	2,448	26	5.3	1,990	283	5.4	1,776
48	7.4	2,665	4	6.2	2,325	249	6.4	1,889
16	8.3	2,908	1	7.0	1,742	137	7.4	2,201
3	9.2	2,605	1	8.1	1,238	38	8.3	2,415
1	10.4	2,608				10	9.4	2,521
1	11.9	2,797				6	10.4	2,214
						1	11.9	2,797
						1	12.6	2,373

A much more positive relationship was anticipated than was revealed by the preceding tables. Such should have been the case since the yield was based on the plant basis as well as on the area or hectare basis, because each variety is represented by 160,000 plants to the hectare. Each plant occupied an area of 625 square centimeters, which is ample for any of the varieties, to permit optimum tillering.

Where such a large area is allotted each plant as in this case, most of the varieties have not the capacity or ability to tiller sufficiently to fully utilize the available space. If on the other hand, the seedlings had been set much closer, the yield figure for area would not have been representative of average plant yield, since the individual plants would not have had the opportunity to attain full normal development.

Had plants been considered only as individuals instead of as portions or the component parts of a variety, the correlation would undoubtedly have been strongly positive.

The subject of tillering has been discussed at some length in another issue of the REVIEW, under another heading.[1] Taking all the evidence in hand, the conclusion is that a strong tillering habit is indicative of productivity, yet its true value or significance is probably not as great as has been thought.

A very strong tillering habit when exercised beyond a given limit does not influence the yield favorably, although it is not known that it has any negative effect. In other words, beyond certain limits any increase in the total number of bearing culms on a given area does not result in correspondingly increased yield. There appear to be marked differences in the operation of the habit itself, such as in the degree of persistence when in competition. That is to say, one variety will tiller more when closely planted than another, yet these relative positions will be reversed when the area per plant is increased. Again, certain varieties are very regular in the habit while others vary somewhat.

Students of the rice plant are apt to refer to studies on the oat and barley plant. In this connection, reference is made to a very interesting paper, prepared by Clyde E. Leighty.[2] The data given were taken on 500 plants of a pure line of 60-day oats. In the correlation of number of culms per plant with yield of grain per plant, the result found was $r=0.8496\pm0.0084$, a very high correlation. In seeking further information on the subject it is shown that the correlation of number of culms per plant and average yield of grain per head per plant is 0.4005 ± 0.0253. Consequently as the number of culms per plant increased the yield of grain produced on each culm increased. Furthermore, it is shown that the weight of grain per panicle was the same on plants with few culms as on plants with many. Furthermore a positive correlation of 0.4226 ± 0.0248 was found with number of culms per plant and average number of kernels per culm per plant.

The inference to be drawn from these figures is that at no stage of development of the plant was the optimum point reached

[1] The Rate of Sowing Nursery Beds; The Age of Seedlings when Transplanted; The Influence of Each, PHILIPPINE AGRICULTURAL REVIEW, Vol. 8, No. 4.

[2] Correlation of Characters in Oats, with Special Reference to Breeding, by Clyde E. Leighty, in Annual Report of the American Breeders Association, 1910.

but each successive stage was a continuation of the effort to fully utilize the environmental advantages available.

The oat plant passes through the successive stages from tillering to maturity much more rapidly than the rice plant, so that if conditions favor tillering in a given direction, it is probable that the successive stages will be similarly affected.

The data on oats are similar to those of Liebenberg [1] on wheat, which Webber [2] used as an illustration of what he termed an environmental correlation.

In our experience with rice we have failed to find such a regular positive progression in the successive stages to completed reproduction. It has been our experience to find that a high degree of tillering would be offset by a lessened number of grains per panicle or if the grains were numerous, a smaller size of grain.

The records show that in the five years each variety has varied in one direction or the other from a quite apparent type-number of culms per plant, type-number of grains per panicle, and type-size of grain and kernel. The variation in each phase might be fairly independent one of the other; in the same direction or in opposite or compensating directions.

According to some authorities rice varieties with culms less than one meter in length are classed as "dwarf" or "short." There are very few varieties here that would fall within this class, practically none of the lowland varieties having as short culms, except under unfavorable growth conditions.

The question often is presented as to whether a short-stemmed variety will yield as much as one with long culms. The tables that follow indicate the existing relationship of culm length to yield. The culm lengths are given in decimeters and the yields of rough rice in quintals per hectare.

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[1] Mitt. des Vereins zur Forderung 1892–93.

[2] Correlation of Characters in Plant Breeding, Herbert J. Webber, Annual Report American Breeders Association, 1906.

Correlation of culm length and yield of grain.

TABLE No. 15.—1909.

Culm length in decimeters.	6	8	10	12	14	16	18	20	22	24	26	28	30	Total.
	Quintals per hectare. — Occurrences.													
11					1		1					1		3
12			1		1	1			2	1				6
13					2	2	2	2	4	1	3	1		17
14			2	1	1	4	8	5	2	1				24
15		2	3	1	4	3	2	3	2	8	2		1	31
16	1	3		6	4	3	10	1	1	1	1	1		32
17	1		2	2	1	6	1	1	1			1		16
Total	2	5	8	10	14	19	24	12	12	12	6	4	1	129

Mean culm length, decimeters, 14.85.
Mean yield, quintals per hectare, 17.63.
Coefficient of correlation, 0.37 ± 0.05.

TABLE No. 16.—1910.

Culm length in decimeters.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	Total.
	Quintals per hectare. — Occurrences.															
11			1		2											3
12		1	1	1	2		1	1	2							9
13	1	1		1	1	5	5	2	3	3	2	1				25
14		1			2	4	3	12	4	2		1				29
15		1	1	2	3	3	7	9	7	7	5	1	3		1	50
16	2	2	2	2	1	3	6	6	5	5	2		1	2		39
17	2				1	7	3	8	2	5	3			1		32
18			1		2	1	9		8	2	3	1		1		28
19				2		1		1	2	3		1				10
Total	5	6	6	8	14	24	34	39	33	27	15	5	4	4	1	225

Mean culm length, decimeters, 15.4.
Mean yield, quintals per hectare, 19.5.
Coefficient of correlation, 0.163 ± 0.043.

TABLE No. 17.—1911.

Culm length in decimeters.	6	8	10	12	14	16	18	20	22	24	26	28	Total.
	Quintals per hectare. — Occurrences.												
10	4	7	8	2	6	2	2		1			1	33
11	8	3	6	1	2	5	2	2					29
12	8	8	7	3	7	7	4	3	1		1		49
13	13	12	5	4	3	5	1	5	2	1			51
14	11	6	7		4	2	4	2	2	1	1	1	41
15	3	4	2	4	2	4	1	1	3	1	1	3	29
16	2	2	3	4	3	1		3	2	3		1	24
17				2					2		1		5
Total	49	42	38	20	27	26	14	16	13	6	4	6	261

Mean culm length, decimeters, 12.9.
Mean yield, quintals per hectare, 12.3.
Coefficient of correlation, 0.372 ± 0.035.

Correlation of culm length and yield of grain—Continued.

TABLE NO. 18.—1912.

Culm length in decimeters.	Quintals per hectare.																Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	
	Occurrences.																
11		1															1
12	1	3	4	2	2	2						2					16
13	1	4	4	3	4	1		1	1	2	2	2	1				26
14	2	1		4	2	2	2		3	3	4	3	1		2		29
15	1	1	1	1	1		1	4	5	6	4	4	2	1	3	1	36
16	1						4	4	5	8	4	1		2	1	2	32
17			3	3	2	1	2	4	2	4		1	2				24
18				1	2		1		1	1	3	2	3	2			16
Total	6	10	12	14	13	6	10	13	17	24	17	15	9	5	6	3	180

Mean culm length, decimeters, 14.9.
Mean yield, quintals per hectare, 20.4.
Coefficient of correlation, 0.347±0.044.

TABLE NO. 19.—1913.

Culm length in decimeters.	Quintals per hectare.												Total.
	6	8	10	12	14	16	18	20	22	24	26	28	
	Occurrences.												
10				1									1
11						1							1
12		1	1	4	1	4	1	1	3		1		17
13	1	1	1	2	12	7	13	7		2	2	1	49
14	1	1		5		7	5	4	3	1	1		28
15			1	3	4	1	4	5	3				21
16							1	1			1		3
17								1					1
Total	2	3	3	15	17	20	24	19	9	3	5	1	121

Mean culm length, decimeters, 13.42.
Mean yield, quintals per hectare, 16.89.
Coefficient of correlation, 0.141±0.066.

TABLE NO. 20.—1909-1913.

Culm length in decimeters.	Quintals per hectare.																Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	
	Occurrences.																
10	4	7	8	3	6	2	2		1			1					34
11	8	4	7	1	5	6	3	2				1					37
12	9	13	14	10	13	14	6	5	8	1	2	2					97
13	16	18	10	10	22	20	21	17	10	9	9	5	1				168
14	14	9	9	10	9	19	22	23	14	8	6	5	1		2		151
15	4	8	8	11	14	11	15	22	20	22	12	8	6	1	4	1	167
16	6	7	5	12	8	7	21	15	13	17	8	3	1	4	1	2	130
17	3		5	7	4	14	6	14	7	9	4	2	2	1			78
18			1	1	4	1	10		9	3	6	3	3	3			44
19				2		1		1	2	3		1					10
Total	64	66	67	67	85	95	106	99	84	72	47	31	14	9	7	3	916

Mean culm length, decimeters, 14.30.
Mean yield, quintals per hectare, 17.14.
Coefficient of correlation, 0.361±0.0216.

TABLE No. 21.—*Average culm length per variety and average yield of grain.*

[Association Assembly.]

1909			1910			1911		
Occurences.	Average length culms.	Yield of rough rice per hectare.	Occurrences.	Average length culms.	Yield of rough rice per hectare.	Occurrences.	Average length culms.	Yield of rough rice per hectare.
	Cm.	*Kilos.*		*Cm.*	*Kilos.*		*Cm.*	*Kilos.*
3	118.2	1,673	3	116.7	1,392	38	105.9	1,180
6	127.1	1,819	8	125.1	1,573	36	113.2	1,239
17	135.4	2,175	27	135.4	1,825	55	124.9	1,285
25	144.4	1,938	36	144.6	1,949	61	133.3	1,100
33	154.6	1,932	47	155.3	2,151	41	144.1	1,165
34	165.2	1,699	39	165.4	2,161	32	155.0	1,679
17	175.1	1,645	38	175.1	2,163	25	164.5	1,735
			33	184.5	2,173	7	174.3	2,383
			12	194.3	2,037	1	185.6	2,239
			1	212.5	1,947			
1912			**1913**			**1909-1913**		
1	105.7	715	2	104.9	792	41	105.8	1,150
2	117.7	756	1	119.5	1,763	45	114.3	1,268
15	125.7	1,430	17	127.8	1,727	101	125.7	1,423
26	134.2	1,681	52	135.0	1,699	183	135.0	1,560
32	144.6	1,595	29	145.0	1,800	163	144.5	1,652
36	154.8	2,409	21	154.0	1,744	169	154.8	2,060
32	164.2	2,585	3	162.3	2,163	133	164.8	1,841
23	173.7	2,011	1	173.3	2,167	86	174.7	2,018
16	183.0	2,554				50	184.0	2,296
1	195.7	1,880				13	194.4	2,025
1	200.8	1,554				2	206.6	1,750

The culm length seems to be consistently associated with yield even under widely differing conditions. It is pronounced in the drier and hotter seasons, which is anticipated, and was especially notable in 1911.

As in other instances the relationship operates more positively within given limits. It appears that selection of a short-stemmed variety would also include low-yielding capacity, but there is no object in going above the meter and a half limit, in this region.

We have, in selection work, taken the 1.5 meter culm length as the standard, although some of our best cultures have a considerably shorter mode. Culm length itself is not so important with regard to wind resistance as may be believed. The ability of a plant to withstand high winds depends upon the culm structure and root distribution, consequently it has been repeatedly observed that some of the tallest varieties would survive a typhoon while some of the short-stemmed varieties would be completly broken down.

The mode of culm length of varieties apparently varies with the latitude, hence in the northern limits of the rice belt, will be

found the most productive varieties with mean culm lengths so short that similar lengths are not even found in a tropical region.

H. V. Harlan, agronomist in charge of barley investigations in the Bureau of Plant Industry, U. S. Department of Agriculture, in Bulletin No. 137 entitled "Some Distinctions in Our Cultivated Barleys With Reference to their Use in Breeding," cites many instances of the difference in typical culm lengths of varieties of barley, according to the region in which they are cultivated. A given variety in a collection of several, at a certain station would rank as having the longest culms, while at another point where the soil and climate were different, it would be characterized as the one with shortest culms. The writer has noted the striking difference in length of stalk of known varieties of sugar cane when grown in higher altitudes compared with them when grown in the lowlands.

A period of several seasons is required in order that the type culm length of a variety may be ascertained. This fact is more pronounced in the taller varieties. The range of variation in mean culm length in the short-stemmed varieties is quite limited from one season to another, but with the taller varieties as much as five decimeters difference in mean culm length has been found when comparing the figures for two consecutive seasons.

The mean culm length will move above or go below the established type length of culm without having much apparent effect on the production of grain, but when the mean culm length for the season either falls below or passes beyond these limits to deviation from type, a loss in yield results.

One of the most commonly held beliefs concerning the cereals, especially rice and oats, is that those varieties which have panicles bearing many grains each, are therefore very productive. The average person regards with disdain a kind which has but a small number of grains per panicle, thinking that such a one cannot be very productive, but on the other hand, if shown a sample having an unusually large number of grains to the panicle, a request for some seed is nearly always forthcoming.

In the following tables the varieties are assembled into classes according to the number of grains per panicle, employing 50 grains as the unit of measurement. The unit of measurement is too large to permit a smooth array, but the results are not seriously affected thereby.

Correlation of number of grains per panicle to yield of grain.

TABLE No. 22.—1909.

Grains per panicle.	Quintals per hectare.													Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	
	Occurrences.													
100							2	2	1		2	1		8
150	1		3	2	4	6	5	2	3	5		1	1	33
200			4	4	5	6	9	4	5	2	2	2		43
250	1	1	2	1	1	4	4	1	3	3	2			23
300		1		4	2	2	1	1						11
350		2		1	1			1						5
Total	2	4	9	12	13	18	21	11	12	10	6	4	1	123

Mean number grains per panicle, 204.4
Mean yield, quintals per hectare, 17.51.
Coefficient of correlation, —0.260±0.056.

TABLE No. 23.—1910.

Grains per panicle.	Quintals per hectare.															Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	
	Occurrences.															
100			1		3	1	2	2			3					12
150	1	2	2	2	6	7	5	9	6	3	1	2	1	1		48
200	1	2	1	1	5	9	12	13	11	13	2	2	1	3	1	77
250	1		1	4		5	12	10	7	12	9	1	2			64
300			1	1		3	8	5	10	3	2	1	1			35
350				1					2			1				4
Total	3	4	6	9	14	25	39	39	36	31	17	7	5	4	1	240

Mean number grains per panicle, 215.4.
Mean yield, quintals per hectare, 19.92.
Coefficient of correlation, 0.147±0.0426.

TABLE No. 24.—1911.

Grains per panicle.	Quintals per hectare.												Total.
	6	8	10	12	14	16	18	20	22	24	26	28	
	Occurrences.												
50		1				1							2
100	2	1	2	2	1	2	1		1				12
150	3	6	4		1	4		1				1	20
200	1	3	1	1	2	1							9
250	1	2		1		1							5
300		1				1		1			1		4
350		1		1		1							3
Total	7	15	7	5	4	11	1	2	1		1	1	55

Mean number grains per panicle, 174.5.
Mean yield, quintals per hectare, 11.96.
Coefficient of correlation, 0.075±0.090.

Correlation of number of grains per panicle to yield of grain—Continued.

TABLE No. 25.—1912.

Grains per panicle.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
100					1	2		2	1	4	5	3	1					19
150	3	4	4	5	5	2	5	5	9	10	9	9	4	3	5	1		83
200		2	3	7	2		5	3	3	7	3	3	2	3	1	1	1	46
250		1	3	1	4	1	1	1	4	1						1		18
300	3			1	4	1	1			1			1					12
350		1	2															3
Total	6	8	12	14	16	6	12	11	17	23	17	15	8	6	6	3	1	181

Mean number grains per panicle, 180.6.
Mean yield, quintals per hectare, 20.51.
Coefficient of correlation, -0.320 ± 0.045.

TABLE No. 26.—1913.

Grains per panicle.	Quintals per hectare.												Total.
	6	8	10	12	14	16	18	20	22	24	26	28	
	Occurrences.												
50		1			1			1					3
100			2	5	6	8	3				1		25
150		2	1	6	4	8	11	4	4	2	3	1	46
200				4	4	1	6	12	3	1	1		32
250	2				2	1	3	3	1				12
Total	2	3	3	15	17	18	23	20	8	3	4	1	118

Mean number, grains per panicle, 160.5.
Mean yield, quintals per hectare, 16.88.
Coefficient of correlation, 0.257 ± 0.0579.

TABLE No. 27.—1909-1913.

Grains per panicle.	Quintals per hectare.																	Total.
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	Occurrences.																	
50		2			1	1		1										5
100	2	1	5	7	11	13	8	6	3	4	11	4	1					76
150	8	14	14	15	20	27	26	21	22	20	13	14	6	4	5	1		230
200	2	7	9	17	18	17	32	32	22	23	8	7	3	6	2	1	1	207
250	5	4	6	7	7	12	20	15	15	16	11	1	2			1		122
300	3	2	1	6	6	7	10	7	10	4	3	1	2					62
350		4	2	3	1	1		1	2			1						15
Total	20	34	37	55	64	78	96	83	74	67	46	28	14	10	7	3	1	717

Mean number, grains per panicle, 192.6.
Mean yield, quintals per hectare, 18.54.
Coefficient of correlation, -0.0147 ± 0.0251.

TABLE No. 28.—*Average number of grains per panicle per variety and average yield of grain.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average grains per panicle.	Average yield per hectare of rough rice.	Occurrences.	Average grains per panicle.	Average yield per hectare of rough rice.	Occurrences.	Average grains per panicle.	Average yield per hectare of rough rice.
		Kilos.			*Kilos.*			*Kilos.*
9	140.7	2,333	12	136.4	1,948	2	86.5	1,354
33	176.3	1,889	49	182.2	1,923	15	131.3	1,130
47	226.6	1,855	75	225.6	2,111	23	168.6	1,192
26	269.3	1,871	66	274.4	2,128	10	222.8	1,103
13	325.3	1,371	32	315.8	2,118	5	283.8	1,098
5	355.4	1,360	5	377.5	2,120	4	315.2	1,834
						3	337.0	1,141
						1	478.0	-------
1912			**1913**			**1909-1913**		
20	137.8	2,181	5	93.0	943	7	92.8	1,089
85	170.4	2,228	27	125.9	1,518	83	132.8	1,740
49	222.0	2,170	50	172.2	1,806	240	173.9	1,934
19	267.5	1,032	34	218.8	1,914	215	240.0	1,995
11	321.5	1,617	13	274.7	1,442	129	280.5	1,804
3	357.0	917				60	319.8	1,885
						16	359.1	1,483

In field work we have not been able to trace any particular value to the number of seeds per panicle in relation to yield. The type number of grains per panicle for a given variety is determined only by a large number of measurements continued over a period of many years.

In the following tabulation the relationship of the number of grains per panicle to tillering is shown. Since the number of grains per panicle did not have any apparent effect on total yield, but tillering did have a considerable influence on yield, it is anticipated that it will follow that there is a negative correlation between the number of grains per panicle and the number of culms per plant per variety.

Correlation of number of grains per panicle and tillering.

TABLE No. 29.—1909.

Grains per panicle.	Culms per plant.									Total.
	3	4	5	6	7	8	9	10	12	
	Occurrences.									
100				4			1	2	1	8
150	1	1	7	17	4	2	1			33
200			10	26	4	2				42
250		2	8	13	1					24
300			1	10						11
350			3	2						5
Total	1	3	27	72	9	4	2	2	1	123

Mean number grain per panicle, 204.8.
Mean number culms per plant, 5.99.
Coefficient of correlation, -0.324 ± 0.054.

TABLE No. 30.—1910.

Grains per panicle.	Culms per plant.								Total.
	3	4	5	6	7	8	9	10	
	Occurrences.								
100			2	4	3	1	1	1	12
150		2	12	13	11	6	2	1	47
200		6	20	23	12	1	1		63
250	1	8	33	13	6				61
300	1	2	17	7	3				30
350		2	2						4
Total	2	20	86	60	35	8	4	2	217

Mean number grains per panicle, 214.2.
Mean number culms per plant, 5.71.
Coefficient of correlation, -0.199 ± 0.043.

TABLE No. 31.—1911.

Grains per panicle.	Culms per plant.						Total.
	3	4	5	6	7	8	
	Occurrences.						
50				1	2		3
100	3	2	1	3	4	1	14
150	1	5	5	3	6		20
200	1	1	3	3	1	1	10
250		2	1	1			4
300		2	2				4
350	1	2					3
Total	6	14	12	11	13	2	58

Mean number grains per panicle, 168.9.
Mean number culms per plant, 5.29.
Coefficient of correlation, -0.344 ± 0.078.

Correlation of number of grains panicle and tillering—Continued.

TABLE No. 32.—1912.

Grains per panicle.	Culms per plant.									Total.
	3	4	5	6	7	8	9	10	11	
	Occurrences.									
100			3	2	7	2	1	1	1	17
150	1	12	15	19	28	7	2			84
200	1	8	15	9	9	4				46
250	1	5	8	5		1				20
300		6	3	2	1					12
350		1	1							2
Total	3	32	45	37	45	14	3	1	1	181

Mean number grains per panicle, 181.2.
Mean number culms per plant, 5.85.
Coefficient of correlation, -0.222 ± 0.047.

TABLE No. 33.—1913.

Grains per panicle.	Culms per plant.						Total.
	3	4	5	6	7	8	
	Occurrences.						
50		2	1				3
100	3	15	8			1	27
150	5	32	10	2			49
200	3	24	4	2			33
250	5	4	3		1		13
Total	16	77	26	4	1	1	125

Mean number grains per panicle, 160.4.
Mean number culms per plant, 5.00.
Coefficient of correlation, -0.067 ± 0.060.

TABLE No. 34.—1909—1913.

Grains per panicle.	Culms per plant.										Total.
	3	4	5	6	7	8	9	10	11	12	
	Occurrences.										
50		2	1	1	2						6
100	6	17	14	13	14	5	3	4	1	1	78
150	8	52	49	54	49	15	5	1			233
200	5	39	52	63	26	8	1				194
250	7	21	53	32	8	1					122
300	1	10	23	19	4						57
350	1	5	6	2							14
Total	28	146	198	184	103	29	9	5	1	1	704

Mean number grains per panicle, 190.3.
Mean number culms per plant, 5.49.
Coefficient of correlation, -0.182 ± 0.024.

It was found that there was a considerable positive relationship between the degree of tillering habit to yield of grain, being, according to the tabulation, $r=0.419\pm0.018$ (see Table No. 13) but the number of grains per panicle was indifferent in its relation to yield (see Table No. 27). The number of grains per panicle is negatively associated with the tillering habit, so that the increasing number of grains per panicle is found with decreasing number of culms. It therefore appears that tillering and the number of grains per panicle are compensating characters, though not completely so.

In numbers of carefully conducted plot tests the number of culms and the number of grains per culm being identical, a wide variation in yield obtained, which was undoubtedly due to the influence of other characters, kernel weight and size.

Incidentally, this point should perhaps be discussed in another portion of this paper but is mentioned in passing. In order to secure dependable data on yield the average number of fruiting culms per square meter should be determined, the average number of grains per panicle, the volumetric displacement of 1,000 kernels and the weight thereof. Variation in yield cannot be traced to its cause with any dependable degree of accuracy if any of these observations are omitted.

TABLE NO. 35.—*Correlation of grain length and number of culms per plant.*

1909-1913.

Grain length in millimeters.	Culms per plant.											
	2	3	4	5	6	7	8	9	10	11	12	Total.
	Occurrences.											
6.0				2		1						3
6.5			4	4	1	2	2					13
7.0	1	3	15	12	8	8	2	1				50
7.5		11	43	34	30	35	12		1			166
8.0		10	41	51	44	29	5	1		1		182
8.5	2	1	16	41	40	21	11	4			1	137
9.0		4	21	26	31	10	3	3	3			101
9.5			9	28	32	4	1		1			75
10.0			4	16	9	2						31
10.5			2	5	9	2	1					19
11.0				2	2							4
11.5				1	1							2
Total	3	29	155	222	207	114	37	9	5	1	1	783

Mean length of grains mm., 8.32.
Mean number culms per plant, 5.5.
Coefficient of correlation, 0.033 ± 0.024.

It has been said that the long-grained varieties do not tiller freely, but taking the length dimension only, there appears to be no noteworthy correlation between grain length and tillering.

TABLE No. 36.—*Correlation of grain-dimension ratio and tillering.*

1909-1913.

Ratio of width to length of grain.	Culms per plant. 2	3	4	5	6	7	8	9	10	11	12	Total.
	Occurrences.											
1:1.66				1								1
1:2.00		1	14	12	2	9	2		1			41
1:2.33		7	35	41	38	37	8	1				167
1:2.66	1	6	55	61	84	56	15	6	2		1	287
1:3.00		1	30	38	46	15	6	3	1	1		141
1:3.33		1	11	21	23	5	3	1	1			66
1:3.66			2	12	24	3	1					42
1:4.00					9	3						12
Total	1	16	147	186	226	128	35	11	5	1	1	757

Mean ratio of width of grain to length, 1 : 2.74.
Mean number of culms per plant, 5.67.
Coefficient of correlation, 0.053±0.024.

The data we have do not produce any evidence to show that grain shape is correlated to the degree of tillering, considering shape only by two dimensions, length and width.

TABLE No. 37.—*Correlation of grain-dimension ratio and yield of grain.*

1909-1913.

Ratio of width to length of grain.	Quintals per hectare. 6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	Total.
	Occurrences.																		
1:1.66						1													1
1:2.00	2	3	4	6	9	5	2	1	1	4	2	4		1					44
1:2.33	6	11	6	10	13	16	23	15	17	16	12	8	4	2	3	1		2	165
1:2.66	10	13	12	19	26	23	33	42	40	24	22	9	6	4	3		1		287
1:3.00	5	9	9	15	14	13	13	21	12	8	11	7	2	2	1	1			143
1:3.33	1	7	4	6	11	5	13	5	2	8	1	1	1			1		1	67
1:3.66			2	3	1	7	7	6	3	3	1	5	1	2		1			42
1:4.00			1		1	2	4	4		2									14
Total	24	43	38	59	75	72	95	94	75	65	49	34	14	11	7	4	1	3	763

Mean ratio of width to length of grain, 1 : 2.77.
Mean yield, quintals rough rice per hectare, 18.57.
Coefficient of correlation, —0.005±0.024.

The shape of grain bears no relation to the yield, consequently as far as yield of grain itself is concerned any shape of grain may be selected. It is of interest to note, however, that none of the varieties of rice having a pronounced slender type of grain are found in the columns of very low average yields.

While dealing with the subject of the relative values of few or many grains per panicle it is quite important to know the extent of the association of this character with the maturing period.

Correlation of number of grains per panicle to days to maturity.

TABLE No. 38.—1909.

Grains per panicle.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
100	2	1	1	------	1	3	1	------	------	9
150	1	3	3	5	5	11	3	2	------	33
200	------	2	2	6	6	10	7	8	4	45
250	------	------	------	6	5	10	2	1	2	26
300	1	------	------	2	------	3	1	------	5	12
350	------	------	------	------	------	1	------	2	1	4
Total	4	6	6	19	17	38	14	13	12	129

Mean number grains per panicle, 204.2.
Mean days to maturity, 166.8.
Coefficient of correlation, 0.332±0.053.

TABLE No. 39.—1910.

Grains per panicle.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
100	------	2	4	1	5	------	------	------	------	12
150	4	6	6	8	10	6	8	------	1	49
200	1	7	7	4	14	15	15	7	3	73
250	1	2	9	6	10	14	18	2	3	65
300	------	------	4	3	8	5	4	6	3	33
350	------	------	------	------	1	1	------	------	3	5
Total	6	17	30	22	48	41	45	15	13	237

Mean number of grains per panicle, 215.4.
Mean days to maturity, 163.0.
Coefficient of correlation, 0.385±0.037.

TABLE No. 40.—1911.

Grains per panicle.	Days to maturity.								Total.
	130	140	150	160	170	180	190	200	
	Occurrences.								
50	------	1	1	------	------	------	------	------	2
100	1	2	3	3	1	1	3	1	15
150	3	2	6	5	1	3	1	2	23
200	------	------	1	4	1	2	1	1	10
250	------	------	1	1	------	------	1	1	4
300	------	------	2	------	2	------	------	------	4
350	------	2	1	------	------	------	------	------	3
Total	4	7	15	13	5	6	6	5	61

Mean number of grains per panicle, 168.8.
Mean days to maturity, 166.2.
Coefficient of correlation, —0.022±0.088.

Correlation of number of grains per panicle to days to maturity—Continued.

TABLE No. 41.—1912.

Grains per panicle.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
100	1	4	7	2		4	1			19
150		18	22	9	2	5	24	2	1	83
200	1	10	8	8	11	3	4	3	1	49
250		5	7	2		1	3	1		19
300		2	2	1	1	2	1		2	11
350						1			2	3
Total	2	39	46	22	14	16	33	6	6	184

Mean number grains per panicle, 180.4.
Mean days to maturity, 153.7.
Coefficient of correlation, 0.120±0.049.

TABLE No. 42.—1913.

Grains per panicle.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
50		1	2							3
100	2	6	13	3			2		1	27
150	2	8	6	3	3	11	10	4	2	49
200			2	3	6	8	10	6		35
250				2	2	2	4	1	3	14
Total	4	15	23	11	11	21	26	11	6	128

Mean number grains per panicle, 162.5
Mean days to maturity, 160.9.
Coefficient of correlation, 0.625±0.035.

TABLE No. 43.—1909-1913.

Grains per panicle.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
50		1	3	1						5
100	5	14	27	9	9	8	5	3	2	82
150	7	38	39	31	25	34	48	9	6	237
200	2	19	19	22	41	37	38	25	9	212
250	1	7	16	17	18	27	27	6	9	128
300	1	2	6	8	9	12	6	6	10	60
350			2	1	1	3		2	6	15
Total	16	81	112	89	103	121	124	51	42	739

Mean number grains per panicle, 191.6.
Mean days to maturity, 160.9.
Coefficient of correlation, 0.285±0.022.

TABLE NO. 44.—*Average number of grains per panicle per variety and average days to maturity.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average grains per panicle.	Average days to maturity.	Occurrences.	Average grains per panicle.	Average days to maturity.	Occurrences.	Average grains per panicle.	Average days to maturity.
9	140.7	157.1	12	136.4	150.4	2	86.5	153.5
33	176.3	164.7	49	182.2	160.6	15	131.3	164.6
47	226.6	177.0	75	225.6	168.6	23	168.6	161.8
26	269.3	170.8	66	274.4	170.1	10	222.8	174.9
13	325.3	179.7	32	315.8	174.3	5	283.8	178.2
5	355.4	194.2	5	377.5	189.6	4	315.2	165.0
						3	337.0	161.0
1912			**1913**			**1909-1913**		
20	137.8	151.5	5	93.0	138.0	7	92.8	142.4
85	170.4	158.9	27	125.9	154.4	83	132.8	155.9
49	222.0	157.8	50	172.2	165.5	240	173.9	161.7
19	267.5	154.3	34	218.8	175.1	215	240.0	169.2
11	321.5	165.6	13	274.7	183.1	129	280.5	168.2
3	357.0	200.0				60	319.8	173.6
						16	359.1	187.6

The table for 1911 (No. 40) yields an unexpected result, but a reference to records shows that the varieties included in the lower rows were considerably forced by the weather conditions which prevailed that season, the rains terminating abruptly followed by bright sunshine and hot weather which seriously affected the later-maturing varieties, which but for that, would have been distributed in the columns on the left-hand side.

There are very few indeed of the many-seeded varieties that are early maturing, if grown under perfectly normal conditions, consequently as a general guide one should avoid the extremely many-seeded varieties if early maturity is the object.

As stated before the length of the growth period is of very great importance in selecting a variety for culture and for that reason we have tried to find the character most positively associated therewith. Observations on the dimensions of the grain in this relation have also been taken.

The length of grain in millimeters is used for the subject in the following array with maturing periods subdivided into ten-day portions in the relative.

Correlation of grain length and days to maturity.

TABLE No. 45.—1909.

Grain length in millimeters.	Days to maturity. 120	130	140	150	160	170	180	190	200	Total.
	Occurrences.									
6									1	1
7		1				3				4
8	2	2	2	9	11	17	2	3	1	49
9	2	3	4	3	3	12	6	9	9	51
10				4	2	2	6	1	2	17
11						2				2
Total	4	6	6	16	16	36	14	13	13	124

Mean grain length, millimeters, 8.68.
Mean number days to maturity, 167.5.
Coefficient of correlation, 0.104 ± 0.059.

TABLE No. 46.—1910.

Grain length in millimeters.	Days to maturity. 120	130	140	150	160	170	180	190	200	Total.
	Occurrences.									
6				2						2
7	3	4	4		7	2	5	1		26
8	2	11	16	10	20	20	11	7	5	102
9	1	1	9	11	13	13	17	6	4	75
10		1	2	1	5	6	12	1	3	31
11					1	1	1		1	4
Total	6	17	31	24	46	42	46	15	13	240

Mean grain length, millimeters, 8.49.
Mean number days to maturity, 162.9.
Coefficient of correlation, 0.284 ± 0.040.

TABLE No. 47.—1911.

Grain length in millimeters.	Days to maturity. 120	130	140	150	160	170	180	190	200	Total.
	Occurrences.									
6				3			2			5
7		4	4	7	4	7	10	10	2	48
8			1	6	9	5	15	4	3	43
9		1	1	3	7	4	7	3		26
10						2		1		3
11							1			1
Total		5	6	19	20	18	35	18	5	126

Mean grain length, millimeters, 7.81.
Mean number days to maturity, 169.2.
Coefficient of correlation, 0.115 ± 0.041.

Correlation of grain length and days to maturity—Continued.

TABLE No. 48.—1912.

Grain length in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
6			4				1			5
7	2	19	20	4	7	6	19	5		82
8		12	18	13	7	8	10	1	4	73
9		8	3	5		2	2		2	22
10		1	1				1			3
Total	2	40	46	22	14	16	33	6	6	185

Mean grain length, millimeters, 7.65.
Mean number days to maturity, 153.6.
Coefficient of correlation, —0.001±0.036.

TABLE No. 49.—1913.

Grain length in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
6			1					1		2
7	2	12	12	6	4	7	10	7	1	61
8	2	3	10	6	6	13	10	2	3	55
9				1		1	4	1	2	9
10							1			1
Total	4	15	23	13	10	21	25	11	6	128

Mean grain length, millimeters, 7.57.
Mean number days to maturity, 160.6.
Coefficient of correlation, 0.251±0.055.

TABLE No. 50.—1909–1913.

Grain length in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
6			5	5			3	1	1	15
7	7	40	40	17	22	25	44	23	3	221
8	6	28	47	44	53	63	48	17	16	322
9	3	13	17	23	23	32	36	19	17	183
10		2	3	5	7	10	20	3	5	55
11					1	3	2		1	7
Total	16	83	112	94	106	133	153	63	43	803

Mean grain length, millimeters, 8.07.
Mean number days to maturity, 162.1.
Coefficient of correlation, 0.198±0.022.

TABLE No. 51.—*Average length of grain per variety and average days to maturity.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average length of grain.	Average days to maturity.	Occurrences.	Average length of grain.	Average days to maturity.	Occurrences.	Average length of grain.	Average days to maturity.
	mm.			*mm.*			*mm.*	
1	6.8	212.0	2	6.6	150.0	6	6.5	138.5
4	7.7	163.7	25	7.6	155.5	48	7.4	171.9
52	8.5	165.6	102	8.5	165.6	43	8.4	176.1
50	9.4	176.0	75	9.4	171.1	26	9.3	164.7
17	10.5	167.3	31	10.2	177.4	3	10.3	179.0
2	11.2	176.5	4	11.3	181.5			
1912			**1913**			**1909-1913**		
5	6.6	151.6	2	6.9	170.5	16	6.6	152.6
82	7.6	158.2	62	7.6	160.5	221	7.5	161.6
72	8.4	158.2	55	8.2	166.2	324	8.4	164.9
22	9.3	156.2	9	9.2	188.0	182	9.3	169.6
3	10.3	154.3	1	10.7	187.0	55	10.3	173.3
						6	11.2	179.8

Again we have an apparent positive association of two characters but a study of the data reveals the fact that each class has a wide spread, which, coupled with the preponderance of numbers in three classes, permits us to deduce that the figure is somewhat of a mechanical result. There appears to be somewhat of a positive correlation, though probably not sufficiently high to be accorded much weight when selecting varieties, since the distribution is so broad and uniform, exception being taken, of course, to the extremely long types.

It was anticipated that if there was a positive relation between grain length and period to maturity, a negative relation with width would exist. The data thereon are given below.

Correlation of grain width and days to maturity.

TABLE No. 52.—1909.

Grain width in millimeters.	Days to maturity. 120	130	140	150	160	170	180	190	200	Total.
	Occurrences.									
2.0							1	1		2
2.5	1	1	2	3		8	2	2	4	23
3.0	2	4	3	12	14	27	8	9	9	88
3.5	1	1		1	2	1	3	1		10
4.0										
4.5			1							1
Total	4	6	6	16	16	36	14	13	13	124

Mean grain width, millimeters, 2.94.
Mean days to maturity, 167.5.
Coefficient of correlation, —0.146±0.059.

Correlation of grain width and days to maturity—Continued.

TABLE No. 53.—1910.

Grain width in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
2.0						1	1			2
2.5	1	3	8	4	10	9	12	2	4	53
3.0	4	12	19	9	25	27	28	12	8	144
3.5	1	2	3	10	11	5	4	1	1	38
4.0			1	1			1			3
Total	6	17	31	24	46	42	46	15	13	240

Mean grain width, millimeters, 2.97.
Mean days to maturity, 162.9.
Coefficient of correlation, —0.062±0.043.

TABLE No. 54.—1911.

Grain width in millimeters.	Days to maturity.								Total.
	130	140	150	160	170	180	190	200	
	Occurrences.								
2.0		1		3	1	1	2		8
2.5			5	8	9	11	8	1	42
3.0	5	4	10	9	6	19	6	4	63
3.5		1	4		2	4	2		13
Total	5	6	19	20	18	35	18	5	126

Mean grain width, millimeters, 2.80.
Mean days to maturity, 169.2.
Coefficient of correlation, —0.154±0.058.

TABLE No. 55.—1912.

Grain width in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
2.0		1	2				2			5
2.5	1	3	11	8	1	2	11	2	3	42
3.0		14	19	12	11	11	18	4	3	92
3.5	1	14	11	2	2	3	2			35
4.0		6	2							8
4.5		2	1							3
Total	2	40	46	22	14	16	33	6	6	185

Mean grain width, millimeters, 3.10.
Mean days to maturity, 153.6.
Coefficient of correlation, —0.339±0.043.

Correlation of grain width and days to maturity—Continued.

TABLE NO. 56.—1913.

Grain width in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
2.0			1	1	1		1	2		6
2.5	1	4	8	8	1	9	12	4	4	51
3.0	3	10	13	3	8	12	11	5	2	67
3.5		1		1			1			3
4.0			1							1
Total	4	15	23	13	10	21	25	11	6	128

Mean grain width, millimeters, 2.84.
Mean days to maturity, 160.6.
Coefficient of correlation, -0.175 ± 0.057.

TABLE NO. 57.—1909-1913.

Grain width in millimeters.	Days to maturity.									Total.
	120	130	140	150	160	170	180	190	200	
	Occurrences.									
2.0		1	4	1	4	2	6	5		23
2.5	4	11	29	28	20	37	48	18	16	211
3.0	9	45	58	46	67	83	84	36	26	454
3.5	3	18	15	18	15	11	14	4	1	99
4.0		6	4	1			1			12
4.5		2	2							4
Total	16	83	112	94	106	133	153	63	43	803

Mean grain width, millimeters, 2.92.
Mean days to maturity, 162.1.
Coefficient of correlation, -0.237 ± 0.022.

TABLE NO. 58.—*Average width of grain per variety and average days to maturity.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average width of grain.	Average days to maturity.	Occurrences.	Average width of grain.	Average days to maturity.	Occurrences.	Average width of grain.	Average days to maturity.
	mm.			*mm.*			*mm.*	
2	2.3	186.5	2	2.3	181.6	8	2.3	173.7
23	2.7	190.2	52	2.8	168.8	43	2.7	176.1
90	3.2	170.4	145	3.2	167.8	62	3.1	172.0
11	3.6	166.9	38	3.6	162.7	13	3.6	172.3
1	4.5	148.0	3	4.1	160.3			
1912			**1913**			**1909-1913**		
5	2.3	160.6	6	2.3	164.3	23	2.35	172.9
42	2.6	164.2	52	2.7	148.6	212	2.76	169.8
92	3.2	151.6	66	3.1	163.3	455	3.20	167.5
36	3.6	145.6	4	3.6	145.7	102	3.66	157.6
8	4.1	138.5	1	4.0	141.0	12	4.16	145.8
3	4.6	137.3				4	4.57	140.0

The length of grain had a correlation of 0.198±0.022 to days to maturity (Table No. 50), according to the tabulation submitted and width had a correlation of −0.237±0.022 (Table No. 57). In both cases the one dimension was taken without any consideration of its proportion to the other. Anyone familiar with rice knows, of course, that a long grain is not necessarily slender. Judging by the preceding figures, however, it appears that one dimension tends to counteract any relationship which the other may have to period required for maturing the seeds.

It is therefore necessary to learn if there is any correlation to the maturing period when the ratio of width to length of grain is considered. The next table shows that the coefficient of correlation is 0.279±0.021 (Table No. 59), or that as the proportion of length to width of grain increases, the period required to maturity is extended.

It was stated before that six-month varieties appeared to be most numerous. Since the market seems to prefer a somewhat slender type of kernel, this is perhaps one of the principal reasons for the later-maturing varieties being so common.

TABLE NO. 59.—*Correlation of grain-dimension ratio and days to maturity.*

Proportion width to length grain.	Days to maturity.									
	120	130	140	150	160	170	180	190	200	Total.
	Occurrences.									
1:1.66	1	1	1	2						5
1:2.00	2	20	13	5		2	1		1	44
1:2.33	6	26	29	17	22	13	25	11	2	151
1:2.66	7	22	40	40	46	75	57	22	9	318
1:3.00	3	12	20	15	18	21	37	22	15	163
1:3.33	1		5	11	11	12	24	5	10	79
1:3.66			3	5	8	9	11	3	4	43
1:4.00				1	3	3	3	1	1	12
Total	20	81	111	96	108	135	158	64	42	815

Mean ratio width to length of grain, 1 : 2.76.
Mean number of days to maturity, 162.0.
Coefficient of correlation, 0.279±0.021.

The probable effect of the maturing period on yield of grain has been considered (Tables 1 to 7, inclusive). When the study of the culm length to yield was made there was shown a correlation of 0.361±0.0216 (Table No. 20). It was said that within the limits of 120 to 180 days the influence of the maturing period on yield was rather slight; and we now find a somewhat similar application in the table which follows, in that the correlation of culm length to period required to maturity is a parallel case, except that the range is more restricted.

Under normal conditions, as the culms become longer, the season required for maturity is extended.

TABLE No. 60.—*Correlation of culm length per variety and days to maturity.*

1909-1913.

Culm length in centimeters.	Days to maturity.											Total.
	110	120	130	140	150	160	170	180	190	200	210	
	Occurrences.											
100			5	7	17	4	5	3	1			42
110		3	3	8	12	10	2		3	2		43
120		3	24	17	15	7	6	3	13	9	3	100
130		8	33	30	17	19	16	21	16	13	7	180
140		1	16	29	21	21	25	19	13	12	4	161
150	1	2	5	23	14	26	39	31	17	2	7	167
160		1		5	16	19	30	38	12	9	4	134
170				4	7	11	22	27	10	2	1	84
180				4	4	11	10	11	2	8		50
190							5	3	2	3		13
200				1				1				2
Total	1	18	86	128	123	128	160	157	89	60	26	976

Mean culm length, centimeter, 142.9.
Mean days to maturity, 164.0.
Coefficient of correlation, 0.292±0.019.

TABLE No. 61.—*Average culm length per plant per variety and average number of days to maturity.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average length of culms.	Average days to maturity.	Occurrences.	Average length of culms.	Average days to maturity.	Occurrences.	Average length of culms.	Average days to maturity.
	cm.			*cm.*			*cm.*	
3	118.2	150.7	3	116.7	126.3	38	105.9	158.0
6	127.1	150.3	8	125.1	141.8	36	113.2	155.7
17	135.4	162.2	27	135.4	149.6	55	124.9	172.1
25	144.4	163.0	36	144.6	159.4	61	133.3	178.9
33	154.6	172.3	47	155.3	166.8	41	144.1	187.0
34	165.2	184.5	39	165.4	177.8	32	155.0	184.9
17	175.1	180.4	38	175.1	172.3	25	164.5	181.0
			33	184.5	174.7	7	174.3	177.3
			12	194.3	188.8	1	185.7	175.0
			1	212.5	143.0			

1912			1913			1909-1913		
1	105.7	133.0	2	104.9	150.0	41	105.8	157.0
2	117.7	142.0	1	119.5	203.0	45	114.3	153.8
15	125.7	135.1	17	127.8	165.9	101	125.7	160.1
26	134.2	139.4	52	135.0	166.1	183	135.0	163.8
32	144.6	148.9	29	145.1	166.5	163	144.5	164.3
36	154.8	163.6	21	154.0	167.6	169	154.8	170.7
32	164.2	172.3	3	162.3	163.0	133	164.8	177.0
23	173.7	175.2	1	173.3	146.0	86	174.6	174.7
16	183.0	167.5				50	184.0	172.4
1	195.7	170.0				13	194.4	187.3
1	200.8	180.0				2	206.7	161.5

In studying the behavior of the numerous rice varieties which have been included in the plot testing work, numerous tabulations have been made from time to time, of which several are quite interesting and enlightening. For the sake of convenience these tabulations have been termed *association assemblies,* the terms conveying the idea that one character has been compared with another so as to indicate the general trend. Such collections of data are not as definitely valuable as some others, but to many are fully as interesting, since they bear on characters already analyzed and corroborate the evidence presented.

Tables for each of five years and a summary are given on page 109 under several headings, aside from those submitted with a number of the correlation tables.

In the preceding tables it was shown that with tillering (the average number of culms per plant per variety) as the subject, and average yield of grain per variety, as the relative, a positive correlation of 0.419 ± 0.018 was found; also with the average length of culm per variety, as the subject, and the average yield of grain per variety, as the relative, a correlation of 0.361 ± 0.0216, appeared to exist. Of some interest in this connection is the association of tillering and culm length, and in the assembly table which follows an idea can be secured of the manner in which the two characters operate together. Taking only the figures in the rows in which the occurrences are numerous we note in 1909 a slight tendency of the culms to become shorter as the number per plant increased; a similar tendency is shown in 1910, but in 1911, the association is reversed, the shorter culms being found with the smaller number of culms per plant. In 1912 the culm lengths ran irregular which was also the case in 1913. The summary for the five years does not reveal any striking indication of any probable correlation of significant value, hence the assumption that the degree of tillering is practically independent of culm length and culm length is not influenced by the degree of tillering is deemed to be approximately correct.

TABLE NO. 62.—*Average number of culms per plant per variety and average length of culm.*

[Association Assembly.]

1909			1910			1911		
Occurrenees.	Average culms per plant.	Average length of culms.	Occurrences.	Average culms per plant.	Average length of culms.	Occurrences.	Average culms per plant.	Average length of culms.
		cm.			*cm.*			*cm.*
1	3.7	148.0	2	3.8	183.2	2	2.6	109.0
3	4.5	135.9	19	4.6	165.2	21	3.5	119.8
34	5.6	157.8	94	5.5	167.6	78	4.4	129.2
81	6.3	155.3	61	6.3	158.0	82	5.5	131.7
10	7.3	153.8	35	7.3	143.8	66	6.4	138.9
4	8.6	132.1	9	8.2	144.7	43	7.3	140.3
2	9.7	137.5	4	9.5	145.8	8	8.4	149.8
2	10.4	145.6	2	10.3	140.6	1	9.0	125.7
1	12.6	123.6				1	10.6	154.5

1912			1913			1909-1913		
3	3.7	145.3	1	2.8	139.7	3	2.7	119.2
30	4.6	139.2	17	3.6	137.7	44	3.6	129.0
47	5.4	154.9	78	4.3	140.5	208	4.4	128.4
37	6.5	161.6	26	5.3	139.5	283	5.4	151.5
48	7.4	155.7	4	6.2	133.2	249	6.4	152.4
16	8.3	154.5	1	7.0	128.0	137	7.4	147.4
3	9.2	152.5	1	8.1	100.2	38	8.3	147.4
1	10.4	145.6				10	9.4	144.1
1	11.9	141.6				6	10.4	145.0
						1	11.9	141.6
						1	12.6	123.6

There is a correlation of 0.292 ± 0.019 when average length of culm per variety, as the subject, and average number of days per variety to maturity, as the relative, is considered, but apparently little association of culm length and number of culms, either positive or negative, occurs, therefore when the association of number of culms per plant per variety with average number of days to maturity is studied it is hardly apt to manifest any different degree of regularity. At any rate the assembly below does not reveal any evidence to that effect.

The tillering habit is so strongly affected by environment, that even where the best of provisions are made to permit complete development, it is difficult to ascertain if the character is manifesting a true expression. The time period to mature for a given variety varies little compared with the variation in tillering. For that reason, the comparison of the two habits is very apt to show frequent contradictions of even a known tendency. At any rate more data are necessary in order to establish the fact that there is actually any correlation between degree of tillering and time period required to maturity.

TABLE NO. 63.—*Average number of culms per plant per variety and average number of days to maturity.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average culms per plant.	Average days to maturity.	Occurrences.	Average culms per plant.	Average days to maturity.	Occurrences.	Average culms per plant.	Average days to maturity
1	3.7	154.0	2	3.8	154.5	2	2.6	149.5
3	4.5	140.3	19	4.6	172.9	21	3.5	171.6
34	5.6	175.1	94	5.5	176.8	78	4.4	185.5
81	6.3	177.3	61	6.3	161.1	82	5.5	174.5
10	7.3	164.5	35	7.3	153.5	66	6.4	173.4
4	8.6	136.0	9	8.2	143.6	43	7.3	172.8
2	9.7	134.5	4	9.5	130.5	8	8.4	171.2
2	10.4	140.5	2	10.3	143.5	1	9.0	151.0
1	12.6	127.0				1	10.6	183.0
1912			**1913**			**1909-1913**		
3	3.7	161.3	1	2.8	208.0	3	2.7	169.0
30	4.6	154.1	17	3.6	173.7	44	3.6	170.5
47	5.4	156.6	78	4.3	161.8	208	4.4	168.5
37	6.5	171.5	26	5.3	162.6	283	5.4	171.2
48	7.4	157.4	4	6.2	188.2	249	6.4	172.1
16	8.3	155.5	1	7.0	192.0	137	7.4	162.0
3	9.2	138.0	1	8.1	149.0	38	8.3	153.8
1	10.4	121.0				10	9.4	135.6
1	11.9	130.0				6	10.4	145.3
						1	11.9	130.0
						1	12.6	127.0

TABLE NO. 64.—*Average number of nodes per variety and average length of culms.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average nodes per culm.	Average length of culm.	Occurrences.	Average. nodes per culm.	Average. length of culm.	Occurrences.	Average nodes per culm.	Average length of culm.
		cm.			*cm.*			*cm.*
1	4	116.3	1	4.3	146.1	6	4.7	112.1
35	5	147.8	56	5.7	142.9	138	5.5	123.8
74	6	155.0	100	6.5	162.4	123	6.4	142.8
30	7	159.5	59	7.5	171.7	28	7.3	145.8
			5	8.2	188.4			
1912			**1913**			**1909-1913**		
4	4.7	134.0	4	4.7	95.7	16	4.6	115.8
82	5.4	141.3	64	5.6	134.4	375	5.5	134.4
70	6.2	164.4	60	6.3	139.1	427	6.3	152.6
29	7.3	199.1	2	7.2	152.6	148	7.3	167.3
1	8.0	143.5				6	8.2	180.8

A rather remarkable progression in average culm length appears to accompany increase in the average number of nodes per culm. This may be regarded as obvious and fully to be expected, but it does not always occur. Herfril Witte, in a recently published article entitled "Om timotejen, dess historia, odling och formrikedom samt on färädlingsarbetena med detta vallgräs på Svalöff,"[1] states that the number of internodes are not in any degree correlated with straw-length; the same number of internodes may be found on a dwarf type (of timothy) as on a tall type.

Of additional value is the following table which is an association assembly of varieties classified according to the average number of nodes per culm per variety with the average number of days to maturity. Comparing these figures with the association assembly table of average length of culm per variety and average number of days to maturity it is seen that great similarity exists.

Further data of interest is supplied in the summarized association assembly of average number of internodes per variety with average internodal lengths. The close uniformity of internodal length bears out the assumption that a high positive correlation exists between the average number of nodes per variety and the average culm length.

TABLE NO. 65.—*Average number of nodes per variety and average number of days to maturity per variety.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average nodes per culm.	Days to maturity.	Occurrences.	Average nodes per culm.	Days to maturity.	Occurrences.	Average nodes per culm.	Days to maturity.
1	4	135.0	1	4.3	191.0	6	4.7	161.5
35	5	159.4	56	5.7	144.2	138	5.5	166.5
74	6	171.1	100	6.5	165.7	123	6.4	182.1
30	7	189.9	59	7.5	186.5	28	7.3	199.5
			5	8.2	206.8			
1912			**1913**			**1909-1913**		
4	4.7	134.8	2	3.7	114.0	2	3.7	114.0
82	5.4	140.8	4	4.7	127.8	16	4.6	147.7
70	6.2	168.8	64	5.6	148.3	375	5.5	152.6
29	7.3	186.0	60	6.3	179.7	427	6.3	173.6
1	8.2	211.0	2	7.2	189.5	148	7.3	188.9
						6	8.2	207.5

[1] Sorieges Utsadesforening Tidskrift, Vol. 25, No. 4.

TABLE NO. 66.—*Average number of nodes per variety and average internodal lengths.*

[Association Assembly.]

Occurrences.	Average nodes per culm.	Average length internodes.
		cm.
2	3.7	30.81
16	4.6	24.97
375	5.5	24.51
427	6.3	24.10
148	7.3	22.96
6	8.2	22.03

TABLE NO. 67.—*Average length of grain per variety and average length of culm.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average length of grain.	Average length culms.	Occurrences.	Average length of grain.	Average length culms.	Occurrences.	Average length of grain.	Average length of culms.
	mm.	*cm.*		*mm.*	*cm.*		*mm.*	*cm.*
1	6.8	168.9	2	6.6	161.8	6	6.5	131.6
4	7.7	136.5	25	7.6	144.5	48	7.4	124.8
52	8.5	148.2	102	8.5	160.4	43	8.4	139.5
50	9.4	157.6	75	9.4	163.0	26	9.3	130.5
17	10.5	152.0	31	10.2	170.9	3	10.3	148.8
2	11.2	153.0	4	11.3	171.8			
1912			**1913**			**1909-1913**		
5	6.6	147.1	2	6.9	114.1	16	6.6	140.4
82	7.6	152.1	62	7.6	137.3	221	7.5	139.8
72	8.4	157.9	55	8.2	141.5	324	8.4	151.4
22	9.3	152.4	9	9.2	141.9	182	9.3	154.6
3	10.3	146.2	1	10.7	141.7	55	10.3	162.0
						6	11.2	165.7

There appears to be no regular association between culm length and grain length. A short kernel may be borne on a long straw as well as on a short one. It is a tendency, however, of the longer kernels to be found among the taller-growing varieties. It will be noted that for 1910, 1912, and 1913, there is some evidence of progression and parallel increase of length in grain and culm.

TABLE NO. 68.—*Average length of rachis per variety and average length of culm.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average length rachis.	Average length culm.	Occurrences.	Average length rachis.	Average length culm.	Occurrences.	Average length rachis.	Average length culm.
	cm.	*cm.*		*cm.*	*cm.*		*cm.*	*cm.*
1	18.9	128.9	1	15.4	164.0	7	19.2	115.3
30	22.7	138.6	43	23.7	147.1	133	22.7	121.1
46	27.2	152.5	99	27.4	154.6	141	27.1	141.9
55	32.3	161.9	74	32.0	174.9	21	31.9	155.9
4	35.9	158.5	7	36.3	179.1			
1912			**1913**			**1909-1913**		
2	19.1	104.5	6	16.9	78.6	17	18.1	93.0
47	23.6	122.6	36	23.3	134.3	289	23.0	129.8
113	26.9	153.9	73	27.1	142.3	472	27.1	148.8
23	31.3	173.7	15	31.3	150.6	188	32.0	166.8
1	35.0	156.9	1	35.5	136.2	13	36.0	213.9

The evidence supplied above indicates a high positive correlation of average length of rachis per variety with average length of culm. A long rachis will most frequently be found on a long culm. Witte says that there is no correlation between straw length and spike length in timothy, which differs from our observations on rice. Roberts reports a correlation of 0.2922 in wheat of culm length and spike length.[1]

TABLE NO. 69.—*Average diameter of culm per variety and average length of culm.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Mean diameter.	Length of culm.	Occurrences.	Mean diameter.	Length of culm.	Occurrences.	Mean diameter.	Length of culm.
	mm.	*cm.*		*mm.*	*cm.*		*mm.*	*cm.*
6	4.8	150.8	2	4.5	122.1	17	4.6	111.7
18	5.5	144.5	18	5.6	169.7	101	5.5	123.4
56	6.5	150.1	104	6.4	156.4	137	6.4	139.7
30	7.4	158.2	85	7.4	163.9	38	7.2	143.3
4	8.1	162.5	11	8.2	166.0	2	8.1	118.2
			2	9.4	204.7			
1912			**1913**			**1909-1913**		
17	5.6	134.8	21	4.6	126.6	46	4.6	124.0
74	6.3	145.7	74	5.7	138.8	228	5.5	134.6
81	7.4	149.4	34	6.2	147.0	405	6.4	147.1
11	8.2	166.0				234	7.3	154.5
3	9.4	179.0				28	8.2	141.2
						5	9.4	189.4

[1] Variation and Correlation in Wheat, Prof. H. F. Roberts, Annual Report, American Breeders Association, 1910.

It is anticipated that a long culm will necessarily have a corresponding great diameter. There are exceptions, of course, but generally the two dimensions are closely associated in degree.

TABLE No. 70.—*Average length of rachis per variety and average number of branches per panicle per variety.*

[Association Assembly.]

1909			1910			1911		
Occurrences.	Average length rachis.	Average branches.	Occurrences.	Average length rachis.	Average branches.	Occurrences.	Average length rachis.	Average branches.
	cm.			*cm.*			*cm.*	
1	18.9	13.0	1	15.4	14.8	7	19.2	
30	22.7	11.2	43	23.7	11.6	133	22.7	12.9
46	27.2	12.5	99	27.4	12.4	141	27.1	12.3
55	32.3	14.5	74	32.0	14.8	21	31.9	13.0
4	35.9	14.2	7	36.3	16.0			
1912			**1913**			**1909-1913**		
2	19.1	10.1	6	16.9	6.7	17	18.1	
47	23.6	11.8	36	23.3	10.7	289	23.0	11.6
113	26.9	12.4	73	27.1	10.9	472	27.1	12.4
23	31.3	13.7	15	31.3	11.9	188	32.0	14.3
1	35.0	15.0	1	35.5	12.2	13	36.0	15.1

There is apparently a strong positive correlation between length of rachis and number of branches per panicle. As a rule a panicle with a long rachis will also have many branches. Exceptions or variations from this general rule are in part accountable for differences in density of panicle. In order to determine the degree of density, the length of the rachis, the number of branches and their total lineal length and the number of grains must be known.

SUMMARY.

The period of time required to mature a crop of rice, if not less than 120 days nor more than 180 days, does not have any appreciable effect on yield of grain if growth takes place under normal conditions.

Extra early maturity is to be had at the expense of yield.

This statement is based on our experience with a considerable number of both lowland and upland varieties of rice which matured in less than 120 days though not less than 100 days. None of these, however, have produced heavy yields of grain or even satisfactory returns in comparison with varieties requiring a growth period of from 30 to 45 days more.

Very late maturity affords too many opportunities for un-

favorable weather conditions, diseases and pests to injure the plants and thus lower yield of grain.

A variety that tillers freely will produce more grain per hectare than one that does not, but, when rice is transplanted the actual operation of tillering can be very largely regulated by the number of plants set in the hill. The true significance and value of the tillering character is not yet fully apprehended but may be regarded as very desirable. An unusually pronounced tillering habit is not particularly desired in ordinary lowland culture.

It is essential to clearly understand that tillering, the number of grains per panicle and grain or seed size are elastic or compensating characters and that each in turn is affected by the one preceding it and the development of the character is extended or curtailed, as the case may be, by the prevalent environmental conditions and is based upon the extent of the development of the preceding character.

In this connection, the most striking difference between oats and barley and rice should be noted. Oats and barley attain maturity in a very short period of time, passing from the tillering stage to the kernel-forming stage in rapid succession. An ordinary six-month variety of rice, on the other hand, develops slowly, passing through each period of development gradually, consequently it is possible that the plants may enjoy optimum conditions at the tillering stage, the minimum or more probably maximum conditions during a part of the next period, with a possible return to optimum in the succeeding stage; or, the successive stages may be affected variously by a number of combinations in environmental conditions; rarely would optimum conditions prevail throughout. Nevertheless, the degree of tillering, number of grains, size of grains and density of grains are dependent to some extent on the degree of development in each stage and on environmental conditions.

Thus, if tillering has been checked or is not sufficient for the plant's requirements when the seed number is being determined, there will be a close approach to the maximum number of seeds, and if the food supply or water supply is checked, or other unfavorable influences operate later, the seed size is diminished.

Therefore, in passing judgment on a variety, the number of culms per unit of area, the average number of grains per panicle, and the net kernel weight and volumetric measurement must be accurately determined.

The height of the plants, straw or culm, or, as it has been termed before, culm length, has noteworthy influence on yield, but there appears to be no connection between culm number per

plant and average culm length. The highest yields have been obtained by varieties with a culm length of about 1.5 meters and a little over. If the culm length is less than 1.5 meters the yield per hectare diminishes as the average straw length becomes shorter.

The reader should bear in mind that these figures apply only to lowland varieties grown in the low altitudes in the Philippine Islands.

The number of grains per panicle has little influence on yield. The variety with but one hundred grains per panicle may yield as much grain per hectare as one with three hundred.

The number of grains for a variety is dependent on the tillering habit, the grain dimensions and density. As a general rule the varieties which have a large number of grains per panicle have small grains while varieties with few grains per panicle have large grains. Again, the many-seeded varieties do not as a rule stool as freely as the ones having less seeds or grains per panicle.

Grain length considered apart from width has no correlation with the tillering habit, neither does it appear that the slender grains are found on varieties which tiller little, as has been supposed.

The shape of the grain has no effect on yield, nor does there appear to be any correlation of grain shape, in so far as the two dimensions, length and width, are concerned, to the degree of tillering. There appears to be no difference in the amount produced by varieties having short plump grains when compared with those having long slender ones.

The number of grains borne on the panicle is an elastic or compensating character, and for that reason is more widely distributed, but the figures show a rather positive correlation of the number of grains per panicle to the days to maturity. If a variety has an unusually large number of grains per panicle it is quite probable also that it is late maturing.

Varieties that tiller poorly are frequently late maturing, but this habit cannot by itself be given very much weight in attempting to estimate the probable growth period required by any given variety.

Grain length, irrespective of its proportion to width, has a positive correlation to the maturing period, so that to a given extent, the longer the grain the more time the variety requires to reproduce itself. Width of grain acts in the opposite direction and as the grain becomes wider the time period is shortened. When the dimension characters of the grain are considered

separately, they appear to offset each other, but when these dimensions are treated on the basis of the ratio of one to the other, we find that the slender kernel is but seldom found among the early-maturing varieties and as this shape becomes pronounced, it is found only among medium-early and late-maturing kinds. Thus, if a variety has a grain twice as long as it is wide, there is little likelihood of its being anything but an early-maturing sort; if the grain is three times as long as it is wide, the range is very wide but it is more probable that it is medium early to late in maturing; and, if the ratio is four to one, there is hardly any chance that the variety is early.

A similar situation prevails in the maize plant. Varieties having very deep or long grains require a longer period to attain maturity than do varieties with short or shallow grains.

Since the amount of time required to attain maturity, if within the limits indicated above, does not have any marked influence on the yield of grain, the principal interest in this character is with regard to selecting a variety which most suitably fits average rainfall conditions in the district in which it is to be cultivated.

Varieties with culm length of 1 meter to 1.5 meters are widely distributed as to the time period required to maturity, but when the culm length exceeds 1.5 meters the maturing period is more commonly found to be relatively long. For 167 varieties having a culm length of 1.5 meters, the mean growth period was 164.6 days, while 84 varieties with a culm length of 1.7 meters required 172.4 days. One hundred varieties with a mean culm length of 1.20 meters required 157.7 days to maturity. In our region, therefore, varieties with short culms are usually earlier maturing than varieties with long culms. Culm length is positively correlated to the time period required to maturity.

The length of the rachis corresponds to the length of the culm. If the culm is short the rachis will probably be short also.

Long culms have more nodes than short ones. The number of nodes is a more dependable indicator of the normal straw length than one or two seasons' measurements of the culm itself. The length of the culm varies considerably from season to season according to the growth conditions prevailing, but the number of nodes is quite constant, in a given variety.

The number of nodes bears approximately a similar relation to the growth period of a variety as does culm length, hence varieties which have many nodes tend to be later maturing than those with a smaller number.

The length of internodes of a given variety varies considerably

from season to season, but the mean internodal lengths of varieties with a given number of nodes tend to fall within narrow limits and the mean internodal lengths vary but slightly with respect to the number of nodes.

Varieties with few nodes have slightly longer internodes than those with numerous nodes.

The number of nodes have no other bearing on yield than its association and correlation of node number to culm length implies.

More branches are found on a panicle with a long rachis than on one with a short one, and the relation between length of rachis and number of branches is positive and quite regularly progressive when a large population is considered.

The length of the rachis in comparison with the number of branches is a relative index to the density of the panicle.

The length of the grain has a slight positive correlation with the culm length, though there are numerous exceptions, and associations run irregularly. If there are other characters present indicating long culm length, long grains may be regarded as additional corroborative evidence.

Investigators are busily engaged in the attempt to learn what is the proper thing to do and incidentally they learn what not to do. These negative facts are as important as the others, since by having a knowledge of the characters to avoid, the plant breeder can eliminate at the beginning all the material that is likely to prove unsatisfactory and concentrate on that which is promising.

In viewing the foregoing it appears that moderation is a good rule to observe, and, if moderate excellence is attained in all essential characters, very material progress has been made, for nearly all varieties possess the several characters in widely differing degrees.

The real aim of the plant breeder is to approximate excellence in all essential features.

The superlative may be the aim but experience shows that this degree is usually attained only at the cost of some highly desired character.

Of course, any standard is for the time being, only an arbitrary means of measuring results, and as soon as this is attained the standard is again advanced.

Most of the characters of the rice plant vary considerably and to some extent independently of the other characters, but a review of the foregoing leads to the conclusion that when the combination of these several characters is effected, each in a

moderate degree, the highest consistent yield of grain will result. It appears that neither the short nor the very long culm is as closely associated with high yield as is culm of a medium length; not the extra early or the very late, but the medium; not the scant tillering varieties nor the very profuse, but the more moderate; and so forth. The same appears to hold good with the relationship of other characters indirectly associated.

When the modern varieties of cereals are considered it will be noted that the most productive of these do not run to extremes in any character. The most productive barley and oat varieties, for instance, which have more recently been given to the public, are remarkable for their balance or symmetry of characters.

The conclusions of prominent maize breeders appear to indicate that a moderate development of the major characters is most desirable and it is quite noticeable that the word "medium" or some synonym occurs very frequently in their writings on the subject.

Finally, knowing what is to be avoided, there still remains the problem of selecting the most productive individual from among the many which manifest the sought-for indications of merit, but that is more a matter of accurate judgment and carefully kept records. As Dr. H. Hjalmar Nilsson says, "The only unity with which we should work must be the living plant itself and not at all—as had hitherto been supposed—its individual organs; the ear, the grain, etc., to which different hereditary dispositions had been attributed."

NOTES ON COFFEE IN JAVA.[1]

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

The importance of the coffee industry in Java previous to the entrance of the coffee blight, *Hemileia vastatrix,* is well known. When it was found impossible to control this disease by cultural methods or fungicides many new species were introduced from abroad from time to time in the hope of rehabilitating the industry. Two of these have attained commercial importance, *Coffea liberica* and *C. robusta.* Of these *Coffea liberica* was first extensively planted and considered blight resistant, but in time this species also became subject to the blight to such an extent that its cultivation has practically been abandoned in favor of the Robusta coffee.

The status of coffee cultivation in Java and the change that has taken place within the last few years is perhaps best illustrated in the following table:

TABLE I.—*Production of coffee in Java.*

Year.	Arabica.	Liberica.	Robusta.
	Kilos.	*Kilos.*	*Kilos.*
1910	4,552,000	4,146,000	1,861,000
1911	6,177,000	3,661,000	7,666,000
1912	11,631,000	3,339,000	15,557,000
1913	4,555,000	3,123,000	18,207,000
1914	11,941,000	2,227,000	34,268,000

In this table the uncertainty of Arabian coffee is well illustrated as well as the steady decline of Liberica, and the very marked increase in the production of Robusta. Hybrid coffee is still too small an item to appear separate, possibly being included with Liberica which it most closely resembles.

For all practical purposes the coffee grown in Java can be divided into four groups:

1. The Arabian and related coffees.

[1] Extracts from a Report made in November, 1915, after a visit to Java.

2. The Liberica type, including the Excelsa, *Coffea excelsa,* and Abeocuta *Coffea abeocutae.*
3. The Robusta coffee, with which may be included the Canephora, *Coffea canephora,* Quillou, *Coffea quillou,* and Uganda, *Coffea ugandae.*
4. The hybrids.[1]

There are other species and varieties that might be included in groups Nos. 2 and 3, but they have been omitted since they have not yet been tried extensively, or have given unfavorable results in the trials.[2]

Arabian coffee.—Owing to the coffee blight Arabian coffee is now of relatively slight importance in Java. Plantations of this coffee are annually uprooted for replanting to Robusta or hybrid varieties, or to rubber. There are still a few favorably situated districts in high altitudes where, as in the Philippines, Arabian coffee is still grown successfully at a good profit.

The Arabian is the only coffee that does not require artificial drying.

Liberica type.—Among the Liberica types the *Coffea liberica* is the only one that has attained commercial importance. When first imported to Java this coffee was resistant to the blight and it was extensively planted; during recent years, however, a strain of the Hemileia has developed which so severely injures the Liberica that its cultivation has practically been abandoned. The yield averages 600 to 700 kilograms of coffee per hectare and the product of this and allied coffees is now sold at $32.50 per 100 kilograms.[3]

Ten kilograms of berries are required to produce 1 kilogram of marketable coffee. The Liberica coffee has a large, hard berry which requires a special pulper.

The Liberica coffee and all other closely allied varieties or species prefer low altitudes, from sea level to an elevation of 350 meters, one exception being the Excelsa which succeeds well up to 700 meters. All the coffees of this type succeed well even on rather stiff clayey soils and are quite drought resistant,

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[1] The hybrid coffees are placed in a separate group on account of their anticipated future importance.

[2] Seed coffee of superior strains of the species and varieties discussed in this paper and grafted plants of the hybrid coffees may be purchased at reasonable prices by applying to Dr. P. J. S. Cramer, chief, plant breeding station, department of agriculture, Buitenzorg, Java, and to the planters experiment station, Malang, Java.

[3] At the date of writing (November, 1915). The price fluctuates more or less from day to day.

particularly the Excelsa, the most promising species in this group. While more rain is desirable, Dr. Cramer thinks that under other favorable circumstances the various coffees of the Liberica type might be grown with an annual rainfall of 1,200 millimeters.

In this group the Excelsa coffee is the most resistant to the blight and is also the most drought-resistant species in the genus. It is of strong vigorous growth with a somewhat smaller yield than Liberica, to which the coffee is equal in quality. Seven to eight kilograms of berries are required to produce 1 kilogram of coffee.

The Excelsa (Pl. IV) makes an excellent stock for other coffees. It should be planted 3.3 by 3.3 to 3.6 by 3.6 meters apart. The first crop is obtained at the age of 4 to 5 years and a full crop at the age of 7 to 8 years.

The Abeocuta coffee stands between Liberian and Excelsa coffee in vigor and is a trifle more susceptible to the blight than the Excelsa. The Abeocuta should be planted 3 to 3.6 meters apart. The age of fruiting is similar to Excelsa. Eight kilograms of berries make 1 kilogram of marketable coffee. In quality it equals the Excelsa but the yield is lower. The other species in this group have not been sufficiently tested to warrant an opinion as to their value. For comparative yield of this as well as other coffees see Tables III, IV, and V.

Robusta type.—Like the Liberica, the Robusta coffee (Pl. I, II, III, *a* and *b*, and VI, *a*) and its allies, the Canephora, Quillou, and Uganda, were introduced in the search for a Hemileia-resistant coffee. All are equal in quality and command the same price in the market, at present $25 per 100 kilograms.

Robusta is the only variety among these coffees that has attained commercial importance, the other kinds of this group having been introduced only within the last few years.

The coffees belonging to the Robusta group thrive from sea level to an elevation of 1,000 meters, and succeed best at a height of 450 to 700 meters, in a damp climate with abundant rain—2,500 to 3,500 millimeters with a minimum of 2,000 millimeters and no long, dry periods. Under other favorable conditions a drought of two to three months' duration will do no harm but if the drought extends beyond this the year's crop is seriously injured though the trees do not appear to suffer permanently. The Robusta prefers a still atmosphere, and suffers especially from continuous dry winds. It requires a permeable soil of good quality, consisting of volcanic ash or a friable loam; eroded soils are unsuitable. The Robusta is now

the coffee most extensively cultivated in Java as may be seen from Table I, and the area is still on the increase.

The Robusta has been extensively planted as a catch crop in the rubber plantations and as these become of tappable age the coffee will be removed. This will take place within the next 5 years and during this period the rise of production is likely to be much less than during the preceding five-year period, at times possibly coming to an actual standstill. It is also similarly planted in coconut plantations. The use of Robusta as a catch crop for rubber has in some quarters produced the erroneous impression that only in that manner was Robusta profitable to a measurable degree and that it was not planted as a primary crop. This is incorrect, however, since there are large plantations planted to Robusta and this area is steadily increasing.

The Robusta coffee is more precocious than the coffees belonging to the other two groups, coming into bearing at the age of 3 years, and it is by far the best cropper, with a yield of 875 to 1,300 kilograms per hectare under moderately favorable conditions, and of 1,700 to 2,300 kilograms on virgin soil and under favorable circumstances (Pl. III, *a*). Its one defect is that it is not equal in quality to the better grades of the other types and therefore commands a lower price than the Arabian and Liberica. Four to 4.5 kilograms of berries yield 1 kilogram of coffee.

The variety Robusta, belonging to this group, is thus far the most dependable for extended planting. It should be planted 2.1 by 2.1 to 2.7 by 2.7 meters apart.

The Quillou (Pl. II) is a very capricious variety that under favorable conditions occasionally gives far better results than the Robusta, and again under apparently the same conditions is greatly inferior. It is therefore well worthy of a trial but cannot be recommended for general planting until more constant varieties have been developed. It should be planted 2.7 by 2.7 to 3 by 3 meters.

The Canephora, also belonging to this group, differs from the Robusta chiefly in foliage characters, but little if at all from a practical point of view, the coffee commanding the same price. Distance of planting is 2.1 by 2.1 to 2.6 by 2.6 meters.

The Uganda coffee is perhaps the most blight-resistant species belonging to this group, of which it is also the hardiest and the one most adapted to adverse conditions. It should be planted 2.1 to 2.6 meters apart.

Coffee hybrids.—The different species of *Coffea* hybridize readily, and, with the introduction of the new species, numerous

spontaneous hybrids appeared in Java. Most of these have of course been valueless, but there are three named varieties, Kawisari B, Kawisari D, and Kalimás, all hybrids between *C. arabica* and *C. liberica,* which are worthy of cultivation. These so far are practically immune to the Hemileia, are of strong vigorous growth, good habit, endure unfavorable climate and soil conditions better than other coffees, and are constant croppers, with an average yield of from 500 to 600 kilograms of coffee per hectare; 8.5 kilograms of berries are required to make 1 kilogram of coffee. The quality of the coffee is excellent and it commands a price of $35 to $37.50 per 100 kilograms. In Java the planting of the hybrids is on the increase among many of the more progressive growers and the two varieties, "Kawisari B" and "Kawisari D," are considered to be the most profitable in Java in the long run.

The hybrids succeed under the same conditions as the Liberica and Robusta coffees, "Kawisari B" being the best for altitudes above 350 meters, and "Kawisari D" the best below this elevation. Kalimás is the least valuable. The hybrids should be set 3 by 3 meters apart.

Since the hybrids do not reproduce themselves true to seed, they are always grafted, and are grown on Excelsa or Liberica stock. The grafting operation, a simple cleft graft covered with a glass tube to exclude water, is easily performed with satisfactory results even by the natives. It is a curious fact that a graft made from a horizontal branch of the coffee plant always develops into a low, spreading bush and never produces vertical stems (Plate V); therefore in order to obtain grafted plants of normal growth and habit the scions should always be made from a vertical growth. This peculiarity, with the consequent scarcity of scions, has been responsible for the slow disemination of the hybrid coffees in the past. From now on, with greater abundance of propagating material, the spread of the hybrids may be expected to be more rapid. The shield bud used in the propagation of oranges and other citrus fruits is likely to be an improvement on the method employed in Java.

All coffee in Java is topped at from 2 to 2.4 meters above the ground and subsequently kept at this height. Only one to three stems are allowed to develop on one plant; all superflous suckers are removed.

Malaganit, *Leucaena glauca,* is used almost exclusively for shade, planted alternately with the coffee (Plate I). As the plants grow up they are first thinned out and later pruned so as to provide the proper shade. But little shade is required in

the lower elevations; the need of shade increases in proportion to the altitude of the location of the coffee plantation. Again, the demand for shade is also regulated by the number of cloudy days.

One of the most interesting features noted in connection with the propagation of coffee was the utilization of *Leucaena glauca* for shade instead of a plant shed constructed of bamboo.

Table II shows the amount of precipitation in a locality ordinarily well adapted to Robusta coffee. During 1913 the coffee suffered considerably from lack of rain.

TABLE II.—*Record of the rainfall at Bangelan for five years.*[a]

Months.	1909		1910		1911		1912		1913	
	Rainy days.	Rain-fall.	Rainy days.	Rain-fall.	Rainy days.	Rain-fall.	Rainy days.	Rain-fall.	Rainy days.	Rain-fall.
		mm.		*mm.*		*mm.*		*mm.*		*mm.*
January	27	493.1	28	393.4	28	548.6	29	430.2	27	487.8
February	26	541.0	25	530.5	15	182.0	27	426.5	26	304.9
March	28	364.0	25	211.4	18	141.0	29	565.4	30	376.3
April	27	482.2	23	300.5	20	436.8	11	98.2	16	249.0
May	27	398.0	12	135.4	19	193.4	10	116.9	11	35.9
June	26	271.8	14	127.6	19	142.0	-	-	3	6.0
July	20	171.8	13	132.9	10	72.0	4	27.3	3	1.9
August	15	65.6	9	78.1	3	1.1	1	0.1	2	12.1
September	9	90.9	11	97.7	5	4.4	9	21.0	8	5.5
October	22	250.5	24	432.8	19	219.9	19	209.8	9	133.2
November	15	285.1	25	461.2	20	264.2	24	344.1	19	77.6
December	21	273.8	28	485.9	23	341.7	19	424.5	21	356.1
Total	263	3,690.8	237	3,387.4	199	2,520.1	182	2,664.0	175	2,046.3

[a] From the "Jaarboek van het Department van Landbouw, Nijverheid en Handel in Nederlandsch-Indie," 1913.

Tables III, IV, and V have been prepared from the same publication.

Tables III, IV, and V show the comparative yields of various coffee strains grown at the Bangelan Coffee Experiment Station. Attention is called to the fact that the figures in these tables have been prepared under the assumption that all the trees are in bearing; this of course never occurs in the field and a reduction of 10 per cent should be made in each instance in order to obtain the approximate yield of each kind in plantation practice. In the case of the Robusta, Canephora and Uganda coffees, this reduction is offset by the fact that for these varieties the planting distance is approximately one-tenth greater than it would be in plantation practice.

TABLE III.—*Production of selected strains of coffee at Bangelan; 1911, 1912, 1913. Planted in 1908.*

Variety.	Strain No.	Distance of planting.	Trees included in experiment.	Yield of prepared coffee.				
				In piculs[a] per bouw.[b]			Average for three years.	
				1911	1912	1913	Per bouw.	Per hectare.
		Feet.					*Piculs.*	*Kilos.*
Quillou	88	10 by 10	551	14.40	22.98	9.63	15.63	1,379
Do	140	10 by 10	504	16.56	19.08	5.50	13.71	1,210
Do	19	10 by 10	382	21.12	6.89	7.19	11.73	1,035
Robusta	124	10 by 10	396	5.40	17.20	11.38	11.32	999
Do	104	10 by 10	297	6.84	13.68	8.23	9.58	845
Do	83	10 by 10	326	11.52	17.35	15.00	14.62	1,290
Do	78	10 by 10	362	16.60	7.05	12.10	11.91	1,051
Uganda	2	10 by 10	285	10.44	14.25	17.80	14.13	1,247

[a] A Dutch picul equals 61.76 kilos. [b] A Dutch bouw equals 0.7 hectare.

TABLE IV.—*Production of selected strains of coffee at Bangelan; 1912, 1913. Planted in 1909.*

Variety.	Strain No.	Distance of planting.	Trees included in experiment.	Yield of prepared coffee.			
				Per bouw.			Average per hectare for 3 years.
				1912	1913	Average for two years.	
		Feet.		*Piculs.*	*Piculs.*	*Piculs.*	*Kilos.*
Quillou	66	10 by 10	449	8.64	13.00	10.82	955
Do	7	10 by 10	462	16.41	19.54	17.97	1,585
Do	136	10 by 10	336	18.36	15.54	16.95	1,495
Do	89	10 by 10	330	20.95	14.94	17.94	1,583
Do	121	10 by 10	360	29.23	9.13	19.18	1,692
Robusta	105	10 by 10	483	10.22	17.00	13.61	1,201
Do	59	10 by 10	360	15.76	11.42	13.59	1,199
Canephora	21	10 by 10	323	10.80	15.34	13.07	1,153
Do	15	10 by 10	288	7.92	10.21	9.06	799
Do	30	10 by 10	360	15.84	13.45	14.64	1,292

TABLE NO. V.—*Production of selected strains of coffee at Bangelan; 1913. Planted in 1909.*

Variety.	Strain No.	Distance of planting.	Trees included in experiment.	Yield of prepared coffee per bouw.	Yield calculated per hectare.
		Feet.		*Piculs.*	*Kilos.*
Excelsa	118	12 by 12	246	1.62	143
Do	27	12 by 12	224	6.23	550
Do	34	12 by 12	217	3.34	295
Do	51	12 by 12	309	4.23	373
Do	121	12 by 12	250	8.64	762
Abeocuta	Z. Z.	10 by 10	323	3.06	270
Do	4	10 by 10	341	4.74	418

The greatest difference between the old Arabian coffee on the one hand, and the new *Hemileia*-resistant coffees on the other, including the Liberica and Robusta types and the hybrids, in so far as it affects the planter in the preparation of marketable coffee, is that whereas Arabian coffee can be dried in the sun, *all the new coffees require artificial drying in specially constructed drying houses* in order to make possible the removal of the silverskin.

To emphasize the importance of this peculiarity of the new coffees the following is quoted from a communication received from Dr. P. J. S. Cramer,[1] chief, plant breeding station, department of agriculture, Buitenzorg, Java, than whom there is perhaps no greater authority on this subject:

> All the new species of coffee present the difficulty that artificial drying is required in preparing the produce for the market. If the coffee is dried in the sun the silverskin does not separate from the bean which influences the price obtained. How much it is influenced depends of course on the state of the market. Last month there was a sharp rise in coffee prices; at such a time the producer does not need to be so particular about the preparation. If the price is, say, Fl. 42 to 47 per picul ($27 to $30.50) per 100 kilograms, as it was last week, coffee with silverskin will fetch a price of Fl. 5 to 10 ($2 to $4) less per picul than coffee that is prepared properly. But when the market goes down and the buyer becomes more critical, Robusta coffee with silverskin is at a greater disadvantage. If clean Robusta would fetch Fl. 30 per picul ($19 per 100 kilograms) Robusta would be perhaps at Fl. 15 per picul or even lower.
>
> The same applies to Liberian coffees with this difference, that as the Liberican coffee generally commands a higher price than Robusta, sometimes as much as 50 per cent, Robusta being for instance at Fl. 40 ($26) per 100 kilograms and Liberica at Fl. 60 ($38.50 per 100 kilograms) per picul, the difference in the price of cleaned and uncleaned coffee of both Robusta and Liberica being the same, the loss of quality in the Liberica, due to the presence of the silverskin, does not proportionally affect the price of this coffee so seriously as the Robusta.
>
> In trying to establish coffee growing in a country like the Philippines a good deal of attention should be paid to make the quality well up to the standard. If not, the industry would be handicapped from the start.

The Dutch Government has ceased to encourage the cultivation of the new coffees among the natives, partly for the reason that without constant supervision and repeated urging the Javanese do not give the proper attention to the trees, and partly

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[1] During the writer's trip from central to east Java and the stay at the coffee experiment station at Bangelan, he enjoyed the privilege of the genial company of Doctor Cramer, which greatly added to both the educational value and the pleasure of the visit. Whatever merit this paper may possess is due largely to the kind offices of Doctor Cramer.

for the reason that owing to the necessity of artificial drying these coffees are considered to be best adapted for planting in large plantations.

The essential features of an establishment for the preparation of coffee are enumerated on a subsequent page. It might be stated that an abundant flow of clean water is essential for the conduct of the operation, and where the stream is large enough it may of course be utilized for driving the machinery.

The floor of the manufacturing shed is constructed of concrete, at various levels in order to avoid labor expense in the course of the preparation. Open conduits are sunk in the concrete floor for the conveyance of the pulped coffee from the pulper to the fermentation vats, and also for the conveyance of the pulp from the building, all of which is accomplished by means of flowing water.

The process of coffee preparation is as follows:[1]

As they are brought from the plantation the berries are poured in to a swinging measure that records automatically both the amount picked and the wage due the picker. This measure is tripped by a movement of the foot and the berries are dumped and conveyed to the pulper on a lower level of the floor. In passing through the pulper the berries are crushed and the beans and pulp separated, the beans being at once washed and carried to the fermentation vats, and the pulp carried out of the building by separate streams of water. The beans are now allowed to ferment for about three days, or until the fleshy covering of the hull can be washed away. They are then washed and conveyed to the drying house. The drying house is a rather narrow structure of brick, 6 or more meters tall. (Pl. VII.) The heat is developed in a brick furnace, the coffee hulls serving as part of the fuel. The heated air and smoke pass from the furnace to a system of sheet-iron pipes about 30 to 40 centimeters in diameter, located in the lower part of the house, 1.5 meters above the ground. Openings in the walls near the ground provide for the ingress of air, which is heated as it flows upward around the pipes. The upper story of the drying house consists of a floor of perforated iron plates for the passage of the heated air from below. On this floor the coffee is spread in a layer about 10 or more centimeters thick. In the course of the drying, which is completed in two days, the

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[1] For a discussion of the propagation and cultivation of coffee see this REVIEW, Vol. VIII, No. 1, 1915, "Coffee in the Philippines."

coffee is frequently turned over with shovels so as to insure evenness in drying.

After passing through the drying house the coffee goes to the huller, and from there, in the most up-to-date establishments, to the grader, which separates the beans according to their size. The defective beans are finally removed by hand before the coffee is sacked for export.

The artificial drying process has been found necessary in all the blight-resistant coffees in order to make possible the removal of the silverskin, and the drying houses are therefore a recent innovation, and are still in a state of evolution. While it was said that they existed, no arrangement was seen for the mechanical transmission of the wet coffee from the fermentation vats to the drying floor, and there are no appliances for the mechanical stirring of the coffee during the process of drying. It would appear that by the use of such appliances a much more compact drying house with several floors, one above another, having the same capacity for drying coffee as a larger one, could be constructed at less cost than those in use at present. The waste of heat in the drying houses is also very obvious.

The question of the cost of production is necessarily very important, for under equally favorable climatic conditions the Philippines could not profitably produce coffee in competition with other countries if the cost of production should exceed a certain margin. In this connection the cost of production of coffee in Java is of the greatest interest.

In Java, on an estate where labor is obtainable at 8 to 12 cents United States currency, per day, the annual cost of upkeep per bouw (0.7 hectare) is as follows:

Machine cultivation	$0.40
Weeding (hoeing) 6 times per year	4.80
Topping and pruning	2.60
Attention to shade trees	1.60
Clearing jungle around plantation	.16
Sundries	.08
Total	9.64

Cost of harvesting of the crop per picul (61.76 kilograms) of prepared coffee is as follows:

Picking	$1.44
Preparation	0.84
Transportation to nearest port	0.90
Total	3.18

Thus the upkeep is equivalent to $13.77 per hectare and the harvesting to $5.07 per 100 kilograms of marketable coffee.

These figures do not take into consideration interest on the capital invested, depreciation of buildings and machinery, taxes and insurance and salaries of manager and European assistants.

On another coffee estate of 500 bouws (350 hectares) near Malang—the center of coffee production in east Java, where the cost of labor was somewhat higher, or 12 to 14 cents per day, U. S. currency—the annual budget has this appearance:

Upkeep ($15.25 per hectare)	$5,340
Salaries	4,812
Insurance, taxes, interest on investment, etc	2,260
Nurseries	120
Maintenance of buildings and machinery	1,180
Sundries	120
Total	13,832

This corresponds to $39.50 per hectare, including all expenses except the harvesting, which here cost $5.67 per 100 kilograms of marketable coffee.

This estate was once planted to Arabian coffee which on the appearance of the blight was replaced with Liberica, to be in turn succeeded by Robusta. This is now gradually giving place to hybrid coffee, and the manager showed the writer a nursery containing 50,000 plants which were being grafted to the Kawisari hybrids for setting out in the plantation next year.

The cost of upkeep of a plantation in a given locality is about the same for all coffees. The expense of starting a hybrid coffee plantation is slightly higher than for Robusta or Liberica because of the grafting operation. The cost of harvesting the Liberica coffees and the hybrids is somewhat higher than the figures quoted above (which apply to Robusta) for the reason that more berries are required to make 100 kilograms of marketable coffee than is the case with the other coffees.

Three hundred and fifty hectares is considered to be the most economical coffee-plantation unit in Java. The cost of an establishment for the preparation of marketable coffee from this area is thus itemized:

Machinery shed and storehouse	$4,000
Drying house, including drier	8,000
Power plant and transmission	2,000
Two pulpers and 1 huller	800
Fermentation vats	2,000
Sundries	3,200
Total	20,000

In constructing a plant for a plantation of less than 350 hectares the figures for the machinery shed and storehouse, drying house and fermentation vats, could be reduced somewhat but the cost of preparation per 100 kilograms would be greater than in a larger plant. After explaining the situation in the Philippines, the writer discussed this subject very thoroughly with Dr. Cramer, who nevertheless advised against the construction of a smaller plant than the one considered above.

From the foregoing statement it will be noted that the coffee industry in Java, based on the cultivation of the blight-resistant coffees, is very profitable, but that it presents many differences in contrast to the same industry as carried on in the Philippines, and that the introduction of these coffees into this Archipelago does not merely consist in the introduction and distribution of seed, but also of the introduction of improved methods of culture and new methods of preparation. The latter requires the outlay of considerable capital, and is beyond the reach of the smaller grower as an individual. Furthermore, it is obvious that without substantial aid of the Government for a number of years, the coffee industry certainly cannot be reëstablished in the interest of the small growers, and can be taken up only with difficulty by the large growers.

The writer's observations of the soil and climate in both Java and the Philippines lead him to believe that the conditions here, in some parts of the Archipelago, are as favorable as those in Java for the new, blight-resistant coffees. It is true that the industrial conditions, under which these coffees are so profitable in Java, differ considerably from those in the Philippines, but these differences do not seem to present any insurmountable difficulties, and apparently there is a liberal margin of profit in the cultivation of the new coffees.

Special attention should be called to the fact that the new coffees cannot be prepared for the market in small quantities of good quality by the individual grower in competition with Javanese coffee. In order to be profitable they must be handled in bulk, and dried artificially in houses specially constructed for this purpose.

In this connection it will be noted that an investment of $20,000 is necessary for the establishment of a coffee-manufacturing plant. Since it is hardly probable that commercial firms would invest in a venture new to the Philippines, it becomes apparent that if the Government wishes to encourage the culture of the new coffees by the small grower, it would probably be-

come necessary for the Government to provide the means for the construction of what might be called a "coffee central."

In other words the Philippine Government should either be prepared to take up the subject under consideration systematically, with the expectation of making considerable expenditure in advance before the industry is established, or dismiss the idea entirely. A middle course would in all probability result in disappointment to the planters, waste of money on the part of the Government and of individuals, and criticism of those who try to encourage the culture of these coffees in a small way.

It would seem that if the proper arrangements were made for the planting of a sufficient area to coffee in a district so as to insure a sufficient supply of berries for the central, there should be no serious difficulty in the operation of a coffee central by the Government. To this the individual grower could bring his produce and receive credit therefor, and the establishment would subsequently serve as a model to other communities which might wish to engage in coffee culture.

PLATE II.

Courtesy of the Department of Agriculture, Buitenzorg, Java.

Fullgrown and properly topped Quillou coffee at the Coffee Experiment Station, Bangelan. Leaves partially removed to show productivity and habit of bearing.

UNIV. OF MICH.

Courtesy of the Department of Agriculture, Buitenzorg, Java.

(*a*) Fullgrown and properly topped tree of Robusta coffee in bearing, Java. The leaves have been removed to show habit of growth and bearing, as well as productivity.

(*b*) Fullgrown plant of Robusta coffee, illustrating the result of planting on poor soil, failure to top the plant, and general neglect.

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Courtesy of the Department of Agriculture, Buitenzorg, Java.

Excelsa coffee, Coffee Experiment Station, Bangelan.

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Photo by author.

Grafted plant of hybrid coffee grown from a scion made from a horizontal branch, illustrating spreading habit of plant produced thereby. Tjikeumeuh Experiment Station, Buitenzorg, Java.

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Courtesy of the Department of Agriculture, Buitenzorg, Java.

(*a*) Robusta coffee plantation six months after planting, Java.

Courtesy of the Department of Agriculture, Buitenzorg, Java.

(*b*) Coffee nursery, Java.

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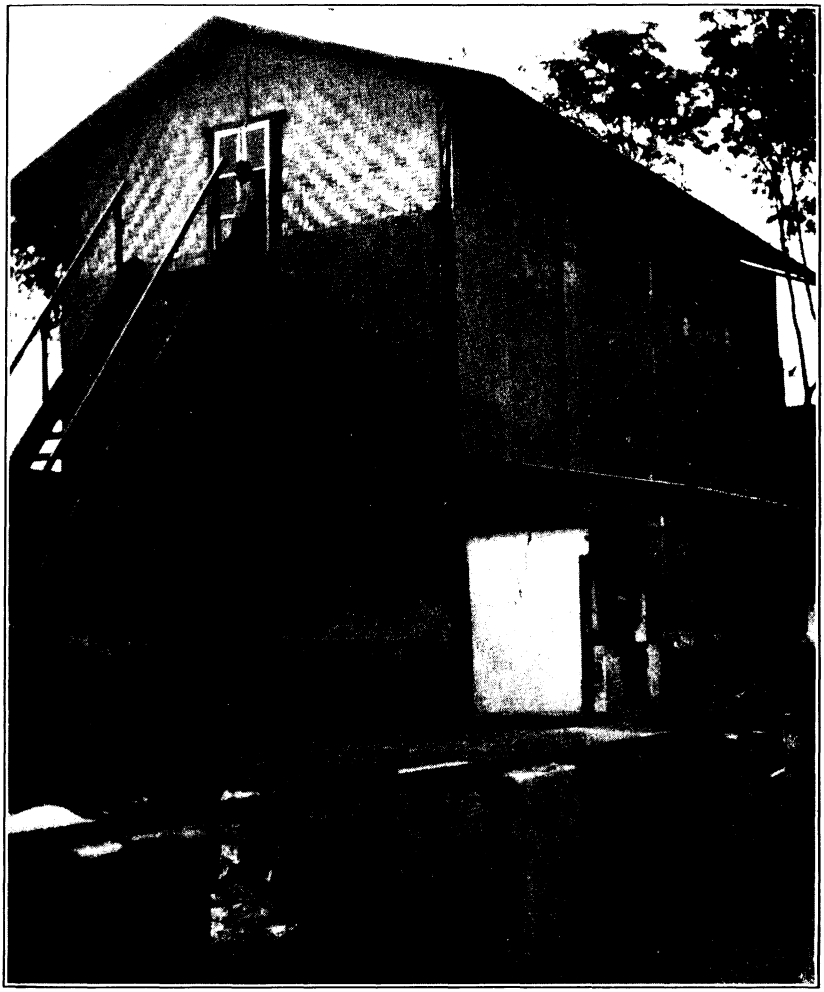

Photo by author.

Drying house for coffee, Coffee Experiment Station, Bangelan, Java.

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CITRUS CANKER[1] INVESTIGATIONS AT THE SINGALONG EXPERIMENT STATION

By E. D. DORYLAND, *Agricultural Inspector.*

During the rainy season of 1915, five rows of nursery stock consisting of *Citrus mitis, C. nobilis* and *C. aurantium,* amounting in all to approximately five hundred seedlings eighteen months old, became infected with citrus canker. So badly infected were these seedlings in some cases, that the petioles were entirely destroyed and the plants were fast becoming defoliated.

The work of the disease was so evident that the writer undertook to check its destructive action by means of sprays. The first attempt was made with Bordeaux; three applications of (4 : 6 : 50) solution were applied at ten-day intervals without any visible success; apparently the disease was worse than before the Bordeaux was applied.

It may be well to remark here that the rainy season of 1915 was below the normal in rainfall, consequently there were dry periods of a week or ten days, thus allowing adequate time for spraying without the materials being immediately washed away by dashing rains.

The second attempt at canker control was made with a formaldehyde spray, consisting of one part of formaldehyde (approximately 38 per cent solution) to one hundred and twenty parts of water. The last four applications however, were of one to one hundred parts solution. The latter spray was used after it had been demonstrated by experiments that it could be used successfully without defoliating the plants.

Later on, after the disease had apparently disappeared, a solution of Bordeaux-formalin consisting of one part of approximately 38 per cent formaldehyde to 100 parts of (4 : 6 : 50) Bordeaux was applied to the plants and soil, merely as a precautionary measure in case the organism was still in the immediate surroundings.

[1] For a description of the nature of this disease see Vol. IV, No. 1, page 97, of the Journal of Agricultural Research. U. S. Department of Agriculture.

After favorable results with the first two applications of formalin, emphasized by lack of further spread of the disease, the seedlings were severely pruned, the pruners removing not only the infected branches but also the badly infected leaves, which reduced the plants to one-half defoliation.

All trash was removed from the rows and the immediate vicinity, and burned with the refuse from the pruned trees.

In spraying with formaldehyde the entire plant and its immediate surroundings, including the surface of the soil, were given a through "soaking."

After four more applications at ten-day intervals new foliage had appeared and reached approximately normal size without becoming infected. This was so encouraging, and as there were no means of proving that the remaining canker spots on the leaves and branches had lost their virulence, the leaves and branches still containing evidence of canker were removed. Thus the plants were completely defoliated by degrees, and many of the branches were cut off.

No reinfections were noticeable after the sixth spraying until two weeks later, when the land was cultivated, and it is not improbable that the new out break that followed was from undestroyed organisms that may have been buried in the soil beyond the reach of the sprays applied.

This new attack of the disease was met with a formalin spray of one to one hundred parts solution, at the same intervals as before mentioned, and without removing the infected leaves. Four applications were made to combat this latter attack making in all ten applications of formaldehyde sprays before the disease was permanently checked.

At the time of writing, three months after the last application, no new infestations are perceptible. It may be well to note, however, that after each of the next two cultivations the surface of the soil was given a thorough spraying with Bordeaux formalin, one to one hundred solution, so as to destroy or at least hold in check the organisms that may have remained untouched by previous applications. Furthermore, it may be of interest to state that the leaves that still retained the canker spots, as a result of the last infestation, now contain holes where the canker spots have dropped out, thus leaving some of the leaves in a perforated condition.

Formalin sprays, together with saponified solutions of Creolin are being tried out at the Lamao station. Also different percentages of formalin solutions are being tried out at Singalong to

determine the highest percentage of formalin solution that citrus plants will withstand without noticeable injury.

The work at the Lamao station was begun on January 27, 1916, in coöperation with Dr. Edson of the United States Department of Agriculture, and it remains to be seen whether or not these sprays will prove as effective upon the old citrus plants at Lamao as they have proven upon the young seedlings at the Singalong station.

Indebtedness is hereby acknowledged to Mr. W. T. Swingle of the Bureau of Plant Industry, United States Department of Agriculture, for the identification of citrus canker in the Philippines.

THE LIVE-STOCK INDUSTRY OF THE PHILIPPINES.

By C. W. EDWARDS.[1]

The Philippine Archipelago presents many natural features which render it particularly well adapted to live-stock raising. The millions of acres of available open areas make it one of the few countries where ranching may still be conducted on a large scale (See Appendix A). The climate is such that herds range the entire year, no expensive buildings for housing being necessary. Numerous streams furnish a good supply of running water and, contrary to common opinion, there are only comparatively small areas where the dry season is prolonged. There are immense areas, portions of which receive occasional showers during this period while other parts enjoy frequent rains throughout the year with no long dry season.

Of the natural grasses covering the extensive open areas, cogon (*Imperata cylindrica Koeinigii Bentham*) is the most common. It is estimated that these cogon lands aggregate a total area of at least 15 million acres. When this grass is burned over, cut, or kept down by grazing, the young crop makes a fairly satisfactory pasture which is readily eaten by all classes of native stock. Under continuous pasturing, however, it becomes finer and is gradually replaced by the better pasture grasses such as bermuda (*Cynodon dactylon*), luyaluya (*Panicum repens*), carabao grass (*Paspalum conjugatum*), and various sedges. Although it is not the common practice among stockmen to grow supplementary feeds it has been proved that the following may be produced with facility:

- Grasses—*Paspalum dilatatum,* Guinea (*Panicum maximum*), Rhodes (*Chloris gayana*), barit (*Leersia hexandra*), Para (*Panicum barbinode*).
- Coarse forages—Corn, sorghum, Japanese cane, Kafir, and various millets.
- Legumes—Soy beans, cowpeas, Lyon bean, mungos, and peanuts.
- Cereals—Rice, corn, and the millets.

[1] Formerly Chief, Division of Animal Husbandry.

Among the improved grasses *Paspalum dilatatum* is proving particularly well adapted for the establishment of permanent pastures.

Relative to the extent and location of public lands no definite statement can be given as the Spanish Government made no regular survey of such lands and the present Government has not as yet authorized a survey of this nature. Any qualified person or recognized corporation may lease any amount not exceeding 1,024 hectares (approximately 2,530 acres), the lease to run for a period not to exceed twenty-five years with the privilege of renewal for a second period of twenty-five years. The average rental on these leases for the first period does not exceed $0.30 per hectare in ordinary cases. Individuals, copartnerships, corporations and like association may purchase agricultural public land [1] which is not occupied, appropriated or reserved. An individual may not purchase a larger quantity than 16 hectares (approximately 40 acres), a copartnership not more than 16 hectares for each partner, and a corporation or like association an amount not to exceed 1,024 hectares (approximately 2,530 acres).

In certain provinces license may be obtained for the pasturing of unclaimed unoccupied public lands. Under this provision, no charge is made if the number of animals does not exceed 100 head. On all cattle, carabao and horses in excess of this number a fee of $0.25 per head per year is collected and $0.10 per head on sheep or goats.

In considering the possibilities of the live-stock industry in any country, the question of market conditions is a very material factor. In this connection, it is doubtful if there are other countries with equal natural facilities for the growing of live stock and which afford as favorable conditions in this respect as the Philippines. When we consider that this country is importing every year animals, meat, and meat products to the value of approximately $4,000,000 (see Appendix C), while millions of acres of cultivable land lie idle because of an insufficient supply of work cattle and carabao, the situation is a very promising one to the producer in so far as local demand for his product is concerned. Relative to the possible future demand for work animals, it is estimated that there are a total of 12 million acres of cultivable land in the Archipelago of which 7 millions are under cultivation, leaving 5 million acres of arable area uncultivated. The total number of available work

[1] Agricultural lands are defined as nonmineral lands which are deemed more valuable for agricultural than forestry purposes.

animals (cattle and carabao) is estimated at 1,200,000 or one animal to each 10 acres of cultivable land. A good proportion of work animals to area under cultivation is at least one head per every 5 acres; thus in order to place under cultivation the available arable land by utilizing present methods at least 1,200,000 additional work animals are necessary.

Perhaps no one factor has been as potent an influence in keeping people from engaging in the live-stock industry as the existence, to a greater or less extent, of certain epizoötic diseases, principally rinderpest and surra. As a matter of fact, a superficial knowledge only of present conditions tends toward a disregard of certain agencies other than disease which have aided very materially in bringing about these conditions. It is true that the destruction of large numbers of animals followed the appearance of rinderpest and surra. However, during the last decade, all classes of animals with the exception of horses (and these have increased rapidly within the past few years), have steadily increased. It is also true that the demand for these animals during this period has increased much more rapidly than the supply which naturally leads to the assumption that the number of animals is decreasing rather than rapidly increasing and the cause of such apparent decrease is attributed to disease. In fact animals of this country are comparatively free from disease. Tuberculosis, which is causing so much damage in most countries of the world, is practically unknown among the native animals. That herds can be protected from the prevalent diseases has been proved possible through practical experience and example. It may be interesting to note in this connection that during the past few years the death rate from this cause has not equaled 2 per cent of the total number and that more animals in the Philippine Islands die each year from neglect than from contagious diseases. One great trouble lies in the fact that previous to the appearance of rinderpest and surra the ease with which animals could be produced and the rapidity with which they increased caused live-stock growers to neglect their herds, in some cases, almost to the extent of utterly abandoning them, so that upon the arrival of these diseases the habit of inattention had become so fixed that practically nothing was done toward the protection of their herds.

It should be noted that during the period of greatest increase in numbers under the Spanish régime at this time wages were much lower and the purchasing power of the people correspondingly small so that added revenues accruing from the in-

dustry were only relative. Stock raising in the Philippines is comparatively more profitable now than it was fifteen or twenty years ago as certain advantages, such as high prices and good demand, more than offset the difficulties attending the business at the present time.

Regarding the present status of the industry certain practices have brought about deplorable conditions, depriving the business of many a dollar of reasonable revenue. It may be said that the herds of this country have practically been left to shift for themselves, no attention being given to improvement through selection, breeding or better methods of care and handling. Males are very seldom castrated and herds are often found composed of as many males as females. When animals are disposed of, it is generally the best males which are placed on the market, leaving the scrubs at the head of the herd. This system of management has resulted in the deterioration of all classes of animals in the Philippines, the retrogression being most noticeable in relation to size. The present native stocks have decreased to such an extent that their money value is only from 30 to 50 per cent of what it should be. There are other characteristics of the native stock, however which are worthy of consideration; among these may be mentioned their exceeding prolificacy, good rustling qualities and general adaptability to the country. These animals are a product of existing conditions which have acted to create forms best suited to these conditions and in many instances it has been preferable to use these native stocks as a foundation upon which to base gradual improvement rather than attempt a beginning with entirely foreign-bred animals.

In connection with the general work of live-stock improvement, the Bureau of Agriculture maintains three stock farms for the production of pure-bred and high-grade animals for disposal to the public for breeding purposes and for use in public-breeding work. The services of improved sires are offered free to the public at the regular stock farms and at the central and subprovincial stations. Many foreign breeds, of all classes of animals, have been imported from time to time and experimented with relative to their adaptability to the country both as pure breds and as upgrading factors. At present more interest is being exhibited on the part of the public in live-stock improvement than at any time since the establishment of the Bureau and the demand for better breeding stock is much greater than can be supplied from the present herds.

HORSES.

The latest statistics show that there are a total of 215,826 horses in the Archipelago.

From the meager amount of data available it would appear that the present "Filipino pony" is a composite type resulting principally from an admixture of the blood of the Sulu horse of the south with that of the Mexican Creole imported into the northern part of the Archipelago by the Spaniards, together with a sprinkling of Chinese blood. The characteristics of these original types have been so thoroughly blended and the type on the whole has been bred for so many generations without the infusion of foreign blood that at present it is only occasionally that individuals may be found which show the distinctive features of the various foundation stocks. However, the pony of the northern districts, which is the direct result of the Mexican importations, is of a decidedly different strain than the Sulu type which is coarser, more angular in build, massive of head, and in general has less style, action, and vigor than the northern pony.

In size the breed shows a marked individual variation ranging from about 47 to 54 inches in height, the average falling perhaps between 48 and 50 inches. Heights of 53 and 54 or even 55 inches are occasionally met with, but these are rare. It is estimated that not more than 10 per cent of the total number stand over 50 inches.

In many respects, these ponies are the best specimens of horse flesh in the world, being possessed of wonderful endurance and a remarkable combination of quality, vigor, and action. They are exceptionally free from such bone affections as spavins, curbs, and ring-bones; in fact, one of the main breed characteristics is the excellent quality of limbs and feet. However, the conditions to which they have been subject for so many generations have resulted in a marked deterioration in size and conformation. Castration of inferior stock is rarely practised and the most promising males are generally taken up for fancy drivers before they become of breeding age, leaving the poor scrub to head the stud. While a stallion is used as a special driving or saddle animal he is very rarely used for breeding purposes. The degeneracy in conformation is most apparent in the low withers, short sloping croup, low tailhead and the "sickle" and "cowhocked" posterior limbs. While these characteristics are very common, there are many specimens which exhibit these defects only to a slight extent and a few individuals which are excellent throughout in conformation.

Horses are used at present mainly for light driving, packing, and saddle purposes, scarcely ever being used for field or heavy draft work. In this connection, it is doubtful if conditions in this country will ever warrant an attempt to develop a class of animal other than a light carriage type. It is mainly owing to the scarcity of large native ponies and the high prices they command that foreign horses are imported as the former are maintained at less expense, are much less disposed to lameness, last longer, and are more easily handled by the Filipino driver.

Stallions are much more generally used for driving and saddle purposes than mares. Average individuals, 50 to 52 inches in height, command from $100 to $150 and ordinary driving animals from $50 to $75. A harness horse of good size, possessing qualities of speed and exceptional style, will often sell at $200 to $300 and a few ponies of good size, conformation, and evidencing signs of speed are sold for racing purposes at from $200 to $400 and often as high as $500 or $600. However, this source of demand is very limited as at present the Manila course is the only official race track in the Islands. Mares, as a rule, sell at a lower price than males. Ordinary types can be purchased at an average of about $50, while exceptional ones of good size find a ready market at $75 to $100. Grades or mestizos are generally valued at double or more the price of native animals.

The greatest obstacle to horse breeding is the prevalence of surra, the disease being so common and difficult to control in some districts as to practically cause the discontinuance of the industry. However, there are certain districts which are entirely free from surra and still other sections where, although the disease is present, it is entirely sporadic and apparently has no tendency toward becoming epidemic and therefore does not constitute a serious menace to the industry.

Considerable work has been accomplished by the Bureau of Agriculture through the public-breeding stations and the regular Bureau stock farms toward the upgrading of the native stock through the infusion of foreign blood. Among the breeds experimented with the Arabian, Thoroughbred and Morgan are of particular mention. The first-cross colts from these unions are a wonderful improvement over the native types in size and conformation. As yet the cross has not been carried beyond the second generation in a sufficient number of instances to allow the drawing of definite conclusions. Of the breeds mentioned, the Arabian has, in general, proved the most satisfactory, producing apparently a more harmonious cross than some

of the other breeds. This is no doubt due, in a large measure, to the relationship in origin of the two breeds. Pure-bred or even grade Arabs, however, are difficult to obtain and then only at long prices and the smaller types of Thoroughbreds and Morgans have proved very well adapted for this work.

CATTLE.

According to the latest available statistics there are a total of 477,736 cattle in the entire Archipelago, which are quite generally distributed throughout the Islands. (See Appendix B.) Among this number various types and strains are represented; of these perhaps two classes are most common, viz, those presenting characters indicating Chinese origin and those apparently of Spanish derivation. Of the former, two subclasses or strains are noticeable, one, the individuals of which are upstanding and comparatively long and narrow in body conformation, the other, the members of which have a more compact symmetrical body and short well-set legs. There are still others forming a sort of nondescript order which apparently are so far removed from foreign introductions that it is difficult to distinguish any of the characteristics of the initial or basic stock. Aside from these so-called "native cattle" a few pure breds, grades and work stock, imported from Indo-China and China, are distributed throughout the Islands making up the remainder of the total number.

As a rule, these cattle are found in small herds, perhaps at least 85 or 90 per cent in herds of 50 or less, there being but very few droves of 1,000 head or over. Like other classes of animals of this country, in the past they have been woefully neglected, especially those of the larger herds. These herds are often found containing nearly as many bulls as cows, no attention having been given to selection or improvement through the introduction of new and improved blood.

Throughout the provinces, principally due to scarcity and correspondingly high prices, comparatively few cattle are slaughtered at any one of the various provincial and municipal markets. The majority that are utilized for this purpose are small males and work stock and females which owing to old age or other reasons are otherwise unserviceable. Manila is the principal market for native meat animals, the cattle being purchased in the provinces on the hoof and the carcass wholesaled by the arroba (25 pounds) and then retailed by the kilo (2.2 pounds). While the market price of fresh meat in Manila varies greatly with the season and the supply of imported

slaughter animals on hand, $0.10 per pound wholesale may be considered an approximate average carcass price for the year. The price of meat in the provinces will, as a rule, average much higher than at the Manila market. Small animals from the large herds often dress as low as 170 pounds while some of the larger types dress from 400 to 500 pounds, or more. Ordinary males suitable for work animals bring about $40 per head and the better types from $50 to $75.

With the exception of one or two modern establishments and a number of small Spanish dairies in Manila, the dairy industry is not carried on to any systematic commercial extent in the Philippine Islands. Although the Filipino people are not heavy consumers of dairy products, small carabao, native-cattle, and goat dairies are found in or near a number of the larger provincial towns. The cattle of the more improved dairies in Manila are grade Shorthorns and Ayrshires imported from Australia. The demand for dairy products is much greater than the supply and it is difficult to understand why greater attention has not been given to this field of invesment. Milk from the more up-to-date dairies is sold at from $0.15 to $0.20 per quart and cream at about $1; carabao milk from the Filipino dairies, undiluted, brings about $0.15 per quart.

Certain breeds of tropical cattle, such as the Sind and Montgomery, from India, should prove profitable as pure breds for dairy purposes in this country, and there is also the possibility of developing a type through crossing these breeds with some well-known European dairy stock, such as the Holstein. Milk breeds of carabaos are commonly utilized in India for dairy purposes and there is no good reason why they would not be well adapted for the same purpose in this country.

Various European breeds such as the Galloway, Angus, Hereford, and Shorthorns have been imported from time to time by the Bureau of Agriculture and experimented with both as to their adaptability as pure breds and as upgrading factors for crossing with the native stock. Sufficient experimental work has been accomplished to fully demonstrate that these classes as pure breds are, in general, not adapted to local conditions. It may possibly develop that some of these breeds after a few generations could be profitably raised in certain districts such as parts of Mindanao where the climate is more temperate and the varieties of grasses are considered superior to those of the average natural pastures; however, this is at present highly problematical. On the other hand, the grades of most of these breeds obtained from crossing with native and Chinese stock

have proved very promising, being far superior to the common stock in size and conformation and exhibiting fair rustling qualities; this is especially true of the Galloway in some of the Northern Luzon provinces. A number of pure-bred Nellores (Ongoles) were also imported from India a few years ago. These animals possess certain characteristics which have been found to make them particularly well adapted to this country. They are excellent rustlers, are troubled very little by ticks and other insect pests, are practically immune to rinderpest, and are able to transmit this relative immunity, as well as other desirable characteristics, in a marked degree to their offspring when crossed upon the native stock.

Of the various branches of the live-stock industry practicable for this country cattle raising is without doubt the most promising. While the Filipino people cannot be considered as a meat-eating race to any great extent, yet the demand for meat is continually increasing; then there is also the lack of work animals previously mentioned, and the fact that there is an annual importation of chilled and frozen meat from Australia in the amount of 15,000,000 pounds which might be produced locally. Disease (rinderpest), which has been the greatest deterrent factor, can be guarded against through quarantine, immunization, and the introduction of highly resistant crosses such as the Indian types.

CARABAO.

The carabao (a species of water buffalo) is to-day the most important work animal of the Philippines. It is used for all classes of field and draft purposes and, driven in the common two-wheeled cart, also furnishes the only means of transportation for thousands of families. Under the present methods of growing lowland rice, the carabao is indispensable to the Filipino farmer, as this crop is generally planted during the rainy season, at which time the paddies are prepared for planting by working the land into a puddled or semi-liquid state and the carabao is the only work animal which can be used for this purpose.

According to the latest data there are a total of 1,147,433 carabaos in the Philippine Islands (See Appendix B), which are found in nearly all parts of the country. Among this number different types or strains are represented; however, the differentiation between these various classes is not as marked as between the different types of cattle. Very little, if any, attention has been given to improvement, although carabaos, as

a rule, receive much better treatment than do other classes of animals and the deterioration from lack of better breeding methods does not appear to have been as great as among the cattle and horses.

The carabao is, in general, stronger than work bullocks but they increase more slowly than cattle as the period of gestation is longer. In addition, for all classes of work except rice growing, the carabao is inferior in many respects to the bullock as he cannot be worked during the heat of the day, is much slower and is more susceptible to certain diseases. For these reasons the carabao is, in many cases, gradually being replaced by work cattle; especially is this true in many of the sugar-growing districts.

The principal source of imported carabaos is Indo-China. The Indo-Chinese animal, as a rule, is larger than the native and seems to be preferred to the latter in certain districts. About 10,000 are imported annually.

The price of animals varies greatly with the locality and the season. An average for good young serviceable stock is about $60 per head, although superior individuals often bring $75 and occasionally as high as $100.

SWINE.

In point of numbers, swine must be given first place as there are about 2,285,880 scattered throughout the Islands. (See Appendix B.) Practically no large herds are maintained but each family usually keeps at least one or two brood sows.

These native pigs show traces of the original wild stock in the long sloping head and narrow flat-sided body, and many of the young display the characteristic brown, longitudinal body stripes. Although very poor in conformation they are wonderfully prolific and hardy. Very little attention is given them and they are allowed to run at large and compelled to forage for a greater part of their subsistence.

Pork is the principal meat diet of the Filipino people. Market animals sell at approximately $0.075 per pound, live weight, and at from $0.20 to $0.30 per pound dressed. The average mature animal weighs about 150 pounds. A number of pigs are slaughtered and sold as "lechones" (roasters) when from 25 to 40 pounds in weight, and when used for this purpose bring excellent prices.

The Bureau of Agriculture has, for some years, been raising pure-bred Berkshire pigs for disposal to the public for breeding purposes and for the production of stud stock for free public

service. The Berkshire has proved a most satisfactory cross with the native swine. The grade offspring possess the characteristics of the pure bred to a surprising extent, these characters persisting for a number of generations when crossed back with the native stock. Recently a few Duroc-Jerseys and Yorkshires have been imported but have not been experimented with for a sufficient length of time to warrant the drawing of definite conclusions.

GOATS.

A few native goats are found in nearly every hamlet throughout the Islands, there being a total of about 592,042. (See Appendix B.) They are allowed to run at will scarcely any attempt being made toward proper care and improvement. No definite types are represented and the native animal presents a wide variation in color markings and conformation.

In certain localities, goats are used to a considerable extent for meat purposes, while in other sections they are very rarely utilized for this purpose. Although goat milk is quite a common article of diet in some localities, yet its use among the Filipinos is not as general as would be expected. Goat raising presents a very feasible means of increasing the available food supply of the Filipino family and it is difficult to understand why more attention is not given to this industry. Although, generally speaking, the native goats are poor milkers, individuals which are very good in this respect are sufficiently plentiful to admit of the development of good milking strains, and their meat is, comparatively speaking, of better quality than that of many other classes of native stock.

In Manila and the larger provincial towns goat milk sells at about $0.15 or $0.20 per quart. Good females bring from $3 to $5 each, and males from $4 to $6, and the carcasses sell, on the Manila market, for about $0.15 per pound.

Maltese and Spanish pure-bred goats have been imported by the Bureau of Agriculture with a view toward the upgrading and production of a type of milk goat suitable for this country. The pure-bred Maltese do not seem well adapted to local conditions, the Spanish type being apparently much more hardy. A comparatively large herd of Spanish grades of considerable size is being maintained at the Alabang stock farm. These are being crossed with pure-bred Spanish males in an attempt to develop a type particularly adapted to this country. At the present time the surplus from this herd is disposed of to the public for breeding purposes. Other breeds, from the Tropics,

which should prove suitable to this country are the Nile or Egyptian, Syrian, Malaga and the East Indian.

SHEEP.

Sheep to the number of 118,010 are found in most parts of the Islands although not as numerous or as generally distributed as goats (See Appendix B). They are usually found in small bands, very few large flocks being maintained. Like the goats they are given very little attention, no attempt being made at shearing. They are generally hornless, white in color, with occasionally individuals of mixed dark and white or light brown. The fleece is coarse, open, and very light, as might be supposed from the fact they are never sheared. Adult males average about 75 and females 50 pounds in weight.

It undoubtedly will be many years before the Philippines will become a wool-producing country, although when we consider the production in some of the other tropical countries, the development of this phase of the industry would seem entirely feasible. Aside from the wool, the raising of sheep for slaughter alone would seem to offer very reasonable possibilities as the annual importation of mutton amounts to approximately 804,768 pounds. (See Appendix C.)

Common native animals on the hoof bring from $3 to $4 per head and dressed carcasses wholesale at about $0.20 to $0.30 per pound.

POULTRY.

Although chickens are fairly numerous and common to nearly all portions of the country, poultry raising is nowhere conducted on an extensive commercial scale.

Outside of Manila and a few of the larger provincial towns practically no pure-bred fowls are found; however, nearly every Filipino family keeps a few of the native chickens. These are of a common mongrel variety, are small in size, have tough, poorly flavored flesh, and are layers of small eggs. With the exception of the cocks reserved for the game pit, they receive very little care, although their meat and eggs are common articles of diet among the people.

A number of small flocks representing various pure-bred varieties are to be found in Manila. These are generally grown on a small scale, the work in most cases being conducted as a hobby or side issue. Practically no systematic well-developed plants are to be found. Pure-bred fowls and eggs for breeding purposes bring very good prices, the demand for this class of stock far exceeding the supply. First-grade cocks bring from

$5 to $15 and $20 each and hens from $2.50 to $10. Eggs from pure-bred stock for hatching purposes average about $3 per setting. Fresh selected native eggs for table purposes bring on an average throughout the year at least $0.30 per dozen and the small native fowls about $0.25 each. In the provinces fresh eggs find a ready market at from $0.02 to $0.03 each and the fowls from $0.20 to $0.40 each.

Turkeys, geese, and ducks are not raised to any appreciable extent in this country, the possible exception being found in the town of Pateros, Rizal Province, where native ducks are raised in large numbers. Here the industry constitutes practically the sole occupation of the entire population of the town.

The Philippines present many natural features conducive to poultry raising not met with in temperate countries. An abundance of green feed and grains may be grown at all seasons. The climate is such that very simple buildings are required for housing, and the humidity is greater and the temperature more constant, making incubation more feasible. Diseases are common but providing the same care and attention is applied to the industry here as in the poultry sections of other countries, it is not considered that these offer a greater obstacle toward successful operation here than elsewhere.

APPENDIX A.—*Approximate areas of the Philippine Archipelago covered by the various classes of vegetation.*

[Taken from Bureau of Forestry Bulletin No. 10.]

Classes of vegetation.	Area.	Percentage.
	Sq. miles.	
Virgin forests	40,000	33⅓
Second-growth forests	20,000	16⅔
Grasslands	48,000	40
Cultivated lands	12,000	10
Total	120,000	100

APPENDIX B.—*Live stock in the Philippine Islands.*

Animals.	Calendar year—			
	1911 [a]	1912 [a]	1913 [a]	1914
Horses	151,696	170,861	179,089	215,826
Cattle	315,495	362,230	418,114	477,736
Carabaos	863,649	958,512	1,047,164	1,147,433
Hogs	1,703,078	1,888,122	2,086,736	2,285,880
Goats	455,291	475,794	528,180	592,042
Sheep	93,341	98,656	104,147	118,010

[a] Revised on August 25, 1915.

(*a*) Nellore bull.

(*b*) Nellore cow.

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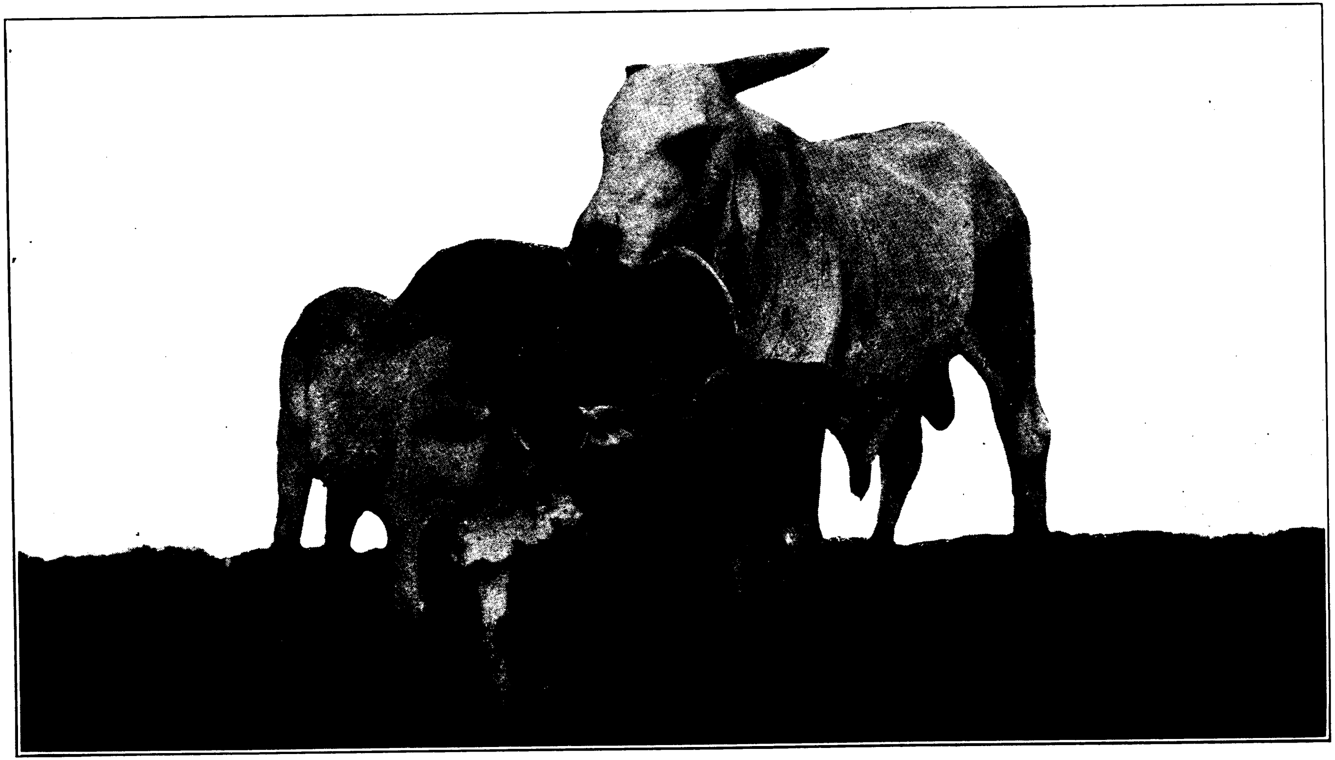

Nellore bull, native cow, mestizo calf. La Carlota Experiment Station.

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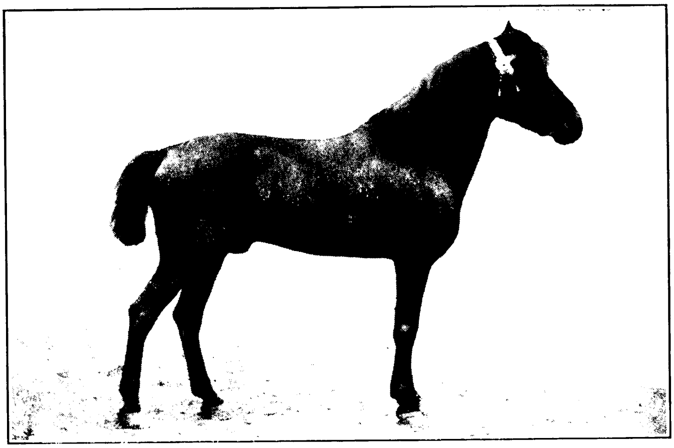
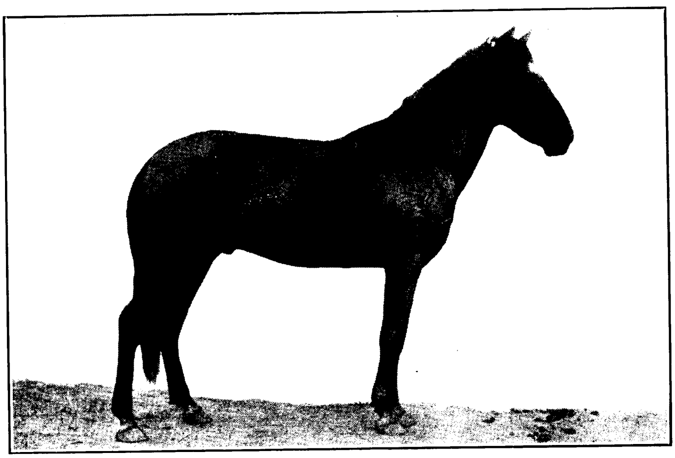


(*a*) Native stallion. Trinidad Stock Farm.



(*b*) Mestizo stallion, Batangas Live-stock Show. Dam, native; sire, "Handrail."

(*c*) Mestiza filly, B-92. Alabang Stock Farm. Age 4 years 3 months; sire, "Duke of Albany" (Morgan); dam, B-33, native; raised at Trinidad Stock Farm.

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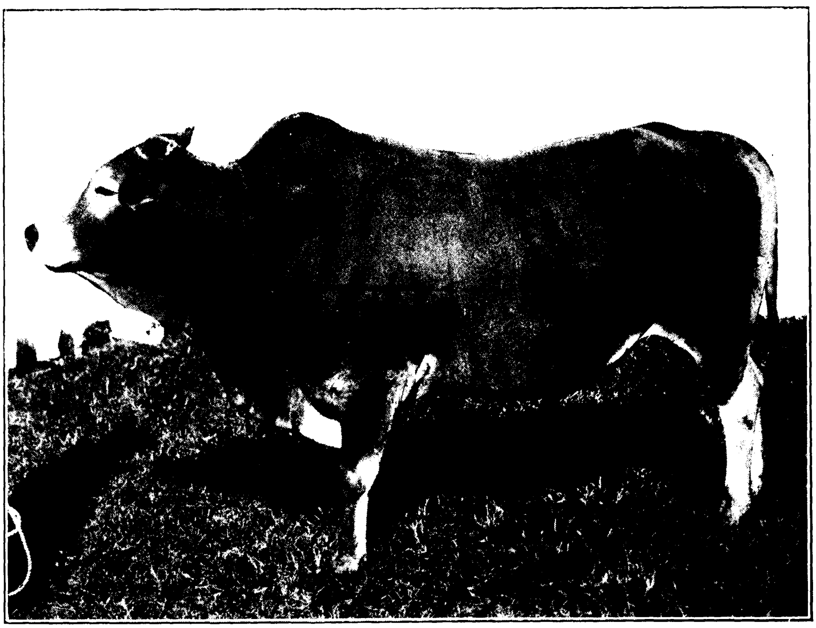
(*a*) Native bull, Spanish type. Batangas draft animal.



(*b*) Native bull. Batangas Live-stock Show.

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Carabaos imported from Indo-China.

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APPENDIX C.—*Animals and animal products imports.*

[From the Annual Report of the Insular Collector of Customs.]

Imports.	1913		1914	
	Quantity.	Value.	Quantity.	Value.
Carabaos and draft cattle	80	$2,666	1,589	$66,557
All other	7,542	165,938	11,089	241,766
Horses	106	11,896	76	6,120
All other		7,926		9,482
	Dozen.		*Dozen.*	
Eggs	4,510,012	382,225	4,609,319	411,365
	Kilos.		*Kilos.*	
Hides and skins	201,597	58,087	219,453	63,272
	Liters.		*Liters.*	
Oils, animal	109,740	19,937	85,324	10,737
Meat and dairy products:				
Fresh—	*Kilos.*		*Kilos.*	
Beef	6,603,851	946,046	5,749,454	882,144
Mutton	358,515	52,801	292,137	48,788
Pork	183,264	52,382	47,614	15,259
Poultry and game		10,345		7,403
All other		10,601		11,394
Canned—				
Beef	265,875	76,269	181,129	62,250
Pork	69,244	25,475	33,770	14,513
Sausage	329,062	111,262	281,520	106,838
All other		31,978		45,115
Dried, smoked, or cured—				
Bacon	107,072	45,017	76,925	35,011
Hams and shoulders	366,923	158,592	446,257	188,480
Sausage	45,148	29,861	40,118	25,732
All other		5,524		4,591
Lard	772,894	159,760	784,136	135,842
Lard compounds and other substitutes for lard	1,432,300	286,167	1,204,133	244,241
Oleomargarine, imitation butter	110,061	30,443	101,497	27,616
All other		20,727		11,057
Dairy products:				
Butter	421,579	237,078	354,828	203,152
Cheese	148,996	58,494	147,491	59,026
Milk, condensed—				
Unsweetened	1,050,982	135,683	1,317,232	207,619
Sweetened	4,007,162	658,512	3,129,399	516,443
	Liters.		*Liters.*	
Milk fresh	1,084,902	121,498	1,201,765	132,033
Total value of animal and animal-products imports		3,913,190		3,793,846

APPENDIX D.—*Carabaos and draft cattle imported.*

Year.	Number.	Value.
1911	19,276	$670,695.00
1912	10,684	451,750.00

APPENDIX E.—*Number and area of various islands.*

Total number of islands		3,141
Total area of Islands	square miles	119,542
Area of Luzon	do	40,969
Area of Mindanao	do	36,292
Islands over 1,000 square miles		9
Islands over 100 square miles		20

CURRENT NOTES—SECOND QUARTER.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao Experiment Station.

THE COFFEE EXPERIMENT STATION, BANGELAN, JAVA.

The coffee experiment station, at Bangelan, East Java, was established in 1901, and is at present managed by Mr. S. Boom, under the direction of Dr. P. J. S. Cramer, chief of the plant breeding station in Buitenzorg. It is located at an altitude of 530 meters and contains an area of 840 hectares, of which 53 hectares are under cultivation to coffee. Sections of the unoccupied land are being cleared annually and set out to coffee as rapidly as funds permit.

The average annual expenses of the station for the last few years have been $10,000, exclusive of salaries—a large part of which is obtained from the sale of coffee seed and plants; the station is thus partly selfsupporting.

The buildings of the experiment station include the residence of the superintendent, one large building in which is located the office, the coffee machinery, consisting of 2 pulpers, and a huller, fermentation vats, and a storeroom for coffee, one storehouse, a drying house for the artificial drying of the blight-resistant coffees (Pl. VII), a rest house for visitors, and houses for assistants and coolies.

All buildings on the premises are lighted by electricity, including the houses of the coolies, and the necessary power for this as well as for driving the coffee machinery, is provided by water conveyed from a spring to the power plant in a concrete conduit 1 kilometer long. This spring also supplies water for washing the coffee.

The activities of the Station may be divided roughly into the following three projects:

1. The amelioration of coffee, including the introduction and testing of new foreign coffee species.
2. The testing of various cultural methods.
3. The growing of seed of improved strains of coffee for sale to planters.

No seeds or plants are distributed gratuitously except to scientific institutions and then only in limited quantities.

When the coffee blight, *Hemileia vastatrix*, appeared in Java, efforts were first made to control the disease by fungicides but while effective sprays were found, their use in plantation practice appeared to be impracticable, and the attention of the men in charge of the coffee investigations was then focused on a search for coffees that were immune or resistant to the Hemileia. The following species have been introduced and are growing at the experiment stations in Bangelan or Buitenzorg:

Coffea robusta.
C. quillou.
C. canephora.
C. canephora var. *madagascariensis.*
C. canephora var. *quillouensis.*
C. canephora var. *sankurensis.*
C. laurentii.
C. ugandæ.
C. congensis.
C. congensis var. *chalotii.*
C. bukobensis.
C. bengalensis.
C. stenophylla.
C. densiflora.
C. pereiri.
C. schumanniana.
C. liberica.
C. arnoldiana.
C. dewevrei.
C. dybowskii.
C. excelsa.
C. abeocuta.
C. aruwiminiensis.

In addition to these there are cultivated several varieties of *Coffea arabica* and hybrids.

By far the largest part of the Bangelan station is devoted to Robusta coffee and its allies, such as the Quillou, Canephora and Uganda; somewhat less space is occupied by the Excelsa and Abeocuta, and the plats of Laurentii and Congensis are still smaller. In the case of the coffees that are merely of botanical interest, only a few plants are grown of each species. Small sections are also planted to varieties of Arabian and Mocha coffee, partly as relics of the time when these coffees were important in Java. These plats are also used in the production of hybrids by planting in them selected trees of blight-resistant species of coffee. Hybridization takes place freely and large numbers of hybrids may thus be obtained without resort to the more tedious method of hand pollination.

The selection and testing work of coffees has been carried on since 1907, with the result that several superior strains have been developed and there are already several fields in which the coffee trees are descendants of a single plant, and from which seed coffee is produced in considerable quantities.

However, even in these cultures, considerable variation is found and it is becoming generally recognized that grafting from individual superior trees must be resorted to in order to obtain the best results. In the cultivation of the hybrids this operation is in fact absolutely necessary, since all the hybrids

that have fruited so far fail to come true to seed and produce an exceedingly variable progeny, which is in most instances inferior to the hybrid parent.

In this connection it might be stated that all inferior seedlings in a given field are gradually being grafted with scions from the best trees of the same number with the result that all trees for seed production will ultimately be of the most desirable trees of that number.

One of the most interesting tests in progress at present is an experiment to determine the most profitable height of topping the different varieties and species.

CROP ROTATION AND IRRIGATION IN JAVA.

To one accustomed to the enormous areas of idle agricultural land in the Philippines the well tilled fields of Java are of great interest. Although there are here and there fair-sized parcels of land still uncultivated, it is nevertheless true that there is very little cultivable waste land in Java; where possible, even the right of way of the railroads is frequently cultivated up to the railway banks.

The system of crop rotation and intensive cropping in Java is worthy of special attention, since without these Java could not at the same time support her large population and maintain her tremendous agricultural exports.

The following is a typical example of crop rotation covering a period of two years:

In July the land is prepared for tobacco, which is set out in three successive plantings in August and September. This is done partly in order to avoid congestion at the time of harvest and to better insure the crop against unfavorable climatic conditions, diseases, and insect pests. The tobacco is harvested in November. Rice is then planted in December and gathered in April or May. This is followed by sesame which is harvested in January. A second planting of rice is then made and this is gathered in June, after which the land is again prepared for tobacco. Altogether five crops are harvested from the same land in the course of two years.

There is of course considerable variation in this system, including also sugar cane, cassava, corn, peanuts, and local crops such as indigo, as well as various vegetables and legumes.

Naturally, this successive cropping is made possible only through an extensive irrigation system. To one familiar with the agricultural situation here in the Philippines, nothing so

forcibly emphasizes the need of extensive irrigation works in this Archipelago as the observation of the agricultural prosperity of Java.

BREEDING FOR STERILITY.

As between productivity and sterility, plants, no less than animals, are practically universally bred to increase productivity. In the case of most fruits the breeder seeks to combine both these characteristics and to obtain productive trees bearing seedless fruits. Cases of breeding with the object of lowering the productiveness are so rare as to be worthy of special notice.

Several years ago the dapdap, *Erythrina subumbrans* (*E. lithosperma*), became so subject to attacks of diseases and insects in Java that it was necessary to find a substitute for it as shade in the coffee plantations. Among the many species that were experimented with by the Dutch Department of Agriculture, the malaganit, *Leucaena glauca,* soon showed its superiority to the others and is now used almost exclusively for that purpose in that Island. However, as is well known, the malaganit is one of the heaviest seed producers among the tropical exogens, and by the constantly dropping seeds, which also germinate promptly, the plant became a nuisance and required frequent weeding out. Dr. P. J. Cramer, chief of the plant breeding station of the Dutch department of agriculture in Buitenzorg, then started a search for malaganit trees with a sparse seeding habit. During a recent visit to Java, Dr. Cramer called the attention of the writer to the first-generation seedlings of these plants at the coffee experiment station in Bangelan, East Java, and the absence of seedpods as compared with other plants was indeed striking. Sterile trees of the malaganit have also been found.

A NEW COVER CROP.

The lima bean, or patani, as it is called in the Philippines, is well known as a vegetable, but many of its friends will perhaps be surprised to hear that it also makes an excellent cover crop. Some time ago its use for this purpose was mentioned by the Basilan Rubber Plantation Company, and the writer recently saw it used to a considerable extent in Hevea rubber plantations in Java.

In the Javanese rubber plantations the patani, or "kratok" as the plant is there called, is sown and allowed to run on the ground in the middles between the rows of rubber trees, leaving a clean cultivated strip of land in which the rubber trees grow.

The vines are cut back from time to time so as not to interfere with the tapping and the collection of latex, and they are of course never allowed to climb up on the rubber trees.

The patani is a native of Brazil, though naturalized in many parts of the Tropics of the Old World.

Being a perennial in the tropics, it is best adapted for a cover crop on land planted to such crops as rubber and coconuts. Here the patani, in addition to its value as a nitrogen gatherer, in preventing soil evaporation in the dry season and in preventing soil erosion during the wet period, is of exceptional value for smothering even such difficult weeds as the cogon, *Imperata arundinacea,* alang-alang, *Imperata sp.,* and nut grass, *Cyperus rotundus.*

For planting as a cover crop, seed of any local vigorous variety will serve. Before planting, the land should be plowed and harrowed. If the seeds are planted in hills 0.5 meter apart each way the land will of course be covered with the patani more rapidly than otherwise, but if seed is scarce a distance of 1 meter between the hills will be found to give good results. Three seeds should be dropped in each hill. One or two hoeings should be given to clear away the weeds until the plants are well established.

FISH CULTURE IN JAVA.

Nowhere else in the Tropics has the utilization of natural resources been carried to the extent that it has been in Java. Not content with the repeated cropping of the land, the culture of a large species of gold fish in the rice paddies is an industry of considerable local importance in certain districts in the island. Another species is reared by the wealthy planters in small concrete tanks where the fish are fed on succulent leaves of various plants, such as cabbage, turnips, pechay, papaya, and various legumes. The "goerme," as this fish is called in Java, attains a length of about 50 centimeters, when it is considered to be of the proper size for the table. The flesh is of excellent quality and contains few bones.

PROSPERITY OF JAVA.

Rubber culture has perhaps attained its highest state of perfection in the Malacca Peninsula, Hawaii leads the world in modern production of sugar, Trinidad is famed for its cacao, and Brazil is the world's chief purveyor of coffee; other countries may excel in certain other crops, but in diversified tropical agri-

culture and the value of its agricultural products Java, considering its area, stands perhaps unparalleled.

Another of the outstanding features of the agricultural and industrial life of Java that cannot fail to impress itself upon the mind of the visitor is the effort to conserve and to utilize to the best advantage all natural resources. The result is that the exports of Java, aside from the large items for sugar, tea, tobacco, etc., include also a multitude of minor products separately insignificant but totalling a very respectable sum in the aggregate.

Everything considered, it is believed that Java and the administrative methods that have brought her wonderful prosperity are worthy of the careful study of every one interested in the economic development of the Philippines.

NOTES ON THE CITRUS CANKER.

Citrus canker was a disease unknown to science until 1913, but since it was first reported from Florida that year its history has been more spectacular than that of most if not indeed all plant pests during the same space of time.

It seems that the citrus canker was introduced from Japan into the Gulf States on *Citrus trifoliata*, and it has been more or less destructive in Florida, Alabama, Mississippi, Louisiana, and Texas. The disease has been particularly virulent in Florida, and in southeast Florida the citrus growers finally resorted to burning the infected trees with flaming oil. The citrus canker was first thought to be a fungus but Hasse demonstrated its bacterial nature in 1915 and named it *Pseudomonas citri.*

Citrus specimens infested with canker were sent from Japan to the Florida experiment station last year, and the disease was found in China by Mr. Walter T. Swingle of the Bureau of Plant Industry, U. S. Department of Agriculture.

The citrus canker was first seen in the Philippines by the writer at the Lamao experiment station in 1912, but here as in Japan it was thought to be merely a virulent form of scab since pruning and application of Bordeaux mixture apparently checked the trouble, which appeared at the end of the rainy season. The disease was first noted on a lot of plants that had been received from the Iwahig penal colony, Palawan, which would indicate that the disease occurs there. However, it may have been introduced to Lamao from India or some part of the Philippines other than Palawan since many plant introductions were made from various sections of the Islands before the canker appeared. While the disease has been present ever since it

was first noted it has never caused serious trouble until at the end of the rainy season of 1914. That it was canker was not known, however, until during the spring of 1915, when herbarium material and budwood was sent to Mr. David Fairchild, agricultural explorer in charge of foreign seed and plant introduction, Bureau of Plant Industry, U. S. Department of Agriculture, who so advised the Bureau of Agriculture upon receipt of the material.

In June of the same year the writer made an inspection trip to southern Luzon, but failed to find any trace of the canker in Albay Province. In Ambos Camarines there was no evidence of the disease except one cankered fruit found in the provincial market of Naga, which was said to have been brought down from a mountain near by. In Sorsogon the canker was found in Bulusan, Barcelona, and other municipalities.

During another visit the canker was found in Tayabas Province and it is also known to occur in Laguna and Batangas.

In the Philippines the writer has noted what is apparently the citrus canker on the following species:

Alemow, *C. macrophylla.*
Biasong, *C. micrantha.*
Cabugao, *C. webberii* var. *montana.*
Cabuyao, *C. histrix.*
Calamondin, *C. mitis.*
Calpi, *C. webberii.*
Canci, *C. histrix* var. *boholensis.*
Colobot, *C. histrix* var. *torosa.*
Colo-colo, *C. pseudolimonum.*
Lemon, *C. limonum.*
Limao, *C. southwickii.*
Lime, *C. limetta,* and its var. *aromatica.*
Limon real, *C. excelsa,* and its var. *davaoensis.*
Mandarin, *C. nobilis.*
Orange, *C. aurantium.*
Pomelo, *C. decumana.*
Samuyao, *C. micrantha* var. *microcarpa.*
Sour orange, *C. vulgaris.*
Taboc, *Aegle glutinosa.*
Talamisan, *C. longispina.*
Tizon, *C. nobilis* var. *papillaris.*
Trifoliate orange, *C. trifoliata.*

Among these species, *C. nobilis, C. n. papillaris, C. mitis* and *C. w. montana* appear to be practically immune to the canker. The *C. aurantium,* and *C. decumana* are very variable, some varieties or trees being quite severely attacked, while others appear to be practically immune. *C. pseudolimonum, C. l. aromatica, C. longispina* and *C. e. davaoensis* are especially subject to the canker, as well as *C. webberii,* while the plants are in the nursery stage. The susceptibility to canker of the imported standard varieties of citrus fruit varies to a remarkable extent.

Generally speaking the canker is most destructive to the plants while they are still small, or less than 1 meter high.

During September and October, 1915, the writer noted the citrus canker both in East and West Java, and in Singapore, and

this, considered in conjunction with its occurrence in the Philippines on some of the most primitive forms among the species in the genus *Citrus* and the native taboc, and its prevalence in China and Japan, makes it very probable that the citrus canker is of wide spread throughout Malaysia, and perhaps India and Ceylon.

ANOTHER EDIBLE ANNONA.

As is well known, the two related genera *Annona* and *Rollinia* contain an unusual number of species with edible fruits. To this number may be added the hitherto unrecorded *Annona montana* Macf. In September, 1915, the writer had the opportunity to sample fruit of this species in the botanic garden of Buitenzorg, Java, and was surprised to find it of remarkably good quality considering that it is entirely unimproved and that it has never been recorded as being edible. The fruit is of about the size of a small custardapple, with sparse, short prickles, greenish, and with yellowish, rather cottony, but juicy and subacid, refreshing pulp, somewhat recalling the flavor of the soursop though inferior to that fruit. It is, however, immeasurably superior to the mamon, *Annona glabra,* the resinous and seedy pulp of which is barely edible.

THE DUKU, *Lansium domesticum* var. *duku.*

The lanzon is a common enough and well esteemed fruit in the Philippines, and it is of good quality. The many friends of the lanzon will therefore perhaps be surprised that it is in reality a very inferior fruit when compared with a variety of the same species, called Duku, which is extensively grown in Singapore and Java.

The following is a description of the duku:

Size, 35 to rarely exceeding 45 millimeters in diameter; form, globose; surface, brownish yellow, fairly smooth, velvety; pericarp, 5 to 6 milimeters thick, rather leathery; flesh divided into five segments, separable from each other and the pericarp, whitish or grayish, semitranslucent, scarcely aromatic, subacid, sweet, juicy, of excellent flavor and quality; seeds, one, rarely more than two, frequently small and deformed. Season, latter part of August, September, and early part of October.

The duku very much resembles the mangosteen in its eating qualities, and is rather more richly but less delicately flavored than that fruit.

The duku, the plant as well as the fruit, is larger than the lanzon. It flourishes under the same conditions as the lanzon

and would undoubtedly thrive in many parts of the Philippines. The best varieties are propagated by marcottage and in all probability the duku could be grafted on the lanzon.

SEEDLESS DURIANS.

In previous issues of this REVIEW we have recorded the occurrence of superior santols, a seedless mabolo, and a sweet camia. So for as the writer is aware absolutely seedless durians have never been recorded, though they probably exist. During a recent visit to Singapore, Dr. I. H. Burkhill, director of the botanic garden, informed the writer that he had noted considerable variations in the durian, and another horticulturist in that city stated that he knew durian trees the fruits of which contained only a few fully developed seeds, with the majority shrunken and only partly developed, and the flesh of which was much superior to that of the average durian. It is hoped that a somewhat less "fragrant" durian may also be discovered, which would probably increase the popularity of this fruit more than anything else, seedlessness not excepted. As has been demonstrated at Lamao the durian is easily propagated by means of shield budding.

THE GERMINATION OF SEED OF CANARIUM.

It is a well known fact that the plantlets of many, even large, seeds of tropical fruits are incapable of penetrating to the surface if planted too deeply, for instance, the mango, bauno, and durian, which ordinarily one would think of as possessing a great reserve of vitality. Comparatively speaking, however, beans, peas, or corn, have far greater vitality in this respect that the species mentioned. The most sensitive species in this regard that has come to the attention of the writer is the pili, *Canarium ovatum*. Some three thousand seeds of this species were last year planted at the Lamao experiment station with a soil cover of 2 to 3 centimeters. The germination was very satisfactory, but when the tender seedlings appeared above ground a large proportion of the plants were unable to pull the cotyledons to the surface without assistance, and the plants broke off just below the cotyledons. Pilis, and probably also other *Canariums*, should therefore be germinated in a very light, porous soil, and should be covered with not more than 1 centimeter of soil.

Filing the nuts will of course hasten germination but it is not necessary, and on a large scale would not be economical.

Seeds of species of *Eugenia* indigenous to wet countries should

be just barely covered with soil in order to insure good germination.

A POSSIBLE SOURCE OF CATTLE FEED FOR THE PHILIPPINES.

In Spain the carob, *Ceratonia siliqua L.*, is an important source of cattle feed, and the culture of the tree there, as well as in Italy, has become so systematized that the tree is even budded and grafted. Being a dioecious plant, it is frequently the custom to graft male scions on the fruit-bearing plants in order to insure fructification. No doubt attempts were made by the Spaniards to introduce the carob into the Philippines but if so, they were all abortive, for there seem to be no carob trees anywhere in the Archipelago except in Dapitan, and Mindanao. There, the carob, together with a number of other plants, was undoubtedly introduced by José Rizal when banished there by the Spanish administration.

There is a strong probability that the carob would succeed well in the calcareous soil of Cebu, Bohol and Siquijor, and around Zamboanga, for the carob succeeds with very little rain. The pods are a very highly concentrated feed and should the plant succeed it would go far towards solving the problem here of importation of cattle feed.

MANGO-HOPPER CONTROL.

It is a well known fact that more or less damage is annually done to the mango crop by the mango hopper, *Idiocerus niveosparsus* and *I. clypealis*. Some years they almost destroy the entire crop in certain districts. Five years ago the writer suggested the use of contact sprays for the control of this pest to the Philippine mango growers, and it is therefore of interest to know that experiments with such sprays in India have proved successful. These experiments, as related in a recent issue of the Agricultural Journal of India, were conducted during 1914 and 1915 by E. Ballard, Government entomologist, Madras. The insects treated in these experiments were *Idiocerus niveosparsus*.

The life history of this insect is short and there are apparently many broods during the year, the main ones coming during the flowering season of the mango. The eggs are laid in small slits made in the tender leaves and flower growths, and the insects puncture these and suck out the juice, causing the flowers and the setting fruits to drop off.

Two insecticides were used, crude-oil emulsion and fish-oil spray, of which the latter was found to be the most satisfactory.

The spray was applied to the trees on the appearance of new growth, after which the spraying was repeated every ten days until the fruit had set and was considered to be safe from the insects. The spraying was started in December and concluded in March.

The cost of spraying averaged 8 annas ($0.25) per tree and the increase in the fruit production of the sprayed trees over those not sprayed was valued at 66 rupees ($21.40) per tree, at a price of 4 rupees ($1.30) per 100 mangos, showing that spraying was profitable.

ANOTHER PHILIPPINE FRUIT.

In Vol. V, 1912, page 596, of this Review, a short note called attention to a fruit of unusual promise from Palawan, called tabú. This fruit, said to grow on a vine, is of about the size of a pomelo, and has a thick, smooth rind separable from the flesh in the same manner as the mangosteen. The juicy, subacid flesh, reported to be of an excellent flavor, resembling that of the mangosteen, consists of several segments or locules that separate readily from each other and which contain large ellipsoidal, free stone seeds.

When mention was first made of the tabú no material had been seen of the species except the peel and the seeds of the fruit, and it was impossible to determine even remotely the relationship of the plant. Since that time young seedlings have been sent to the Bureau of Agriculture by Mr. Dean C. Worcester, formerly Secretary of the Interior. These seedlings were in all respects very similar to durian seedlings, and the tabú evidently belongs to the *Sterculiaceæ* and is also undoubtedly very closely related to the durian, *Durio zibethinus L.*

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SPECIAL ARTICLES

THE FOOD PLANTS OF THE PHILIPPINES

By P. J. Wester

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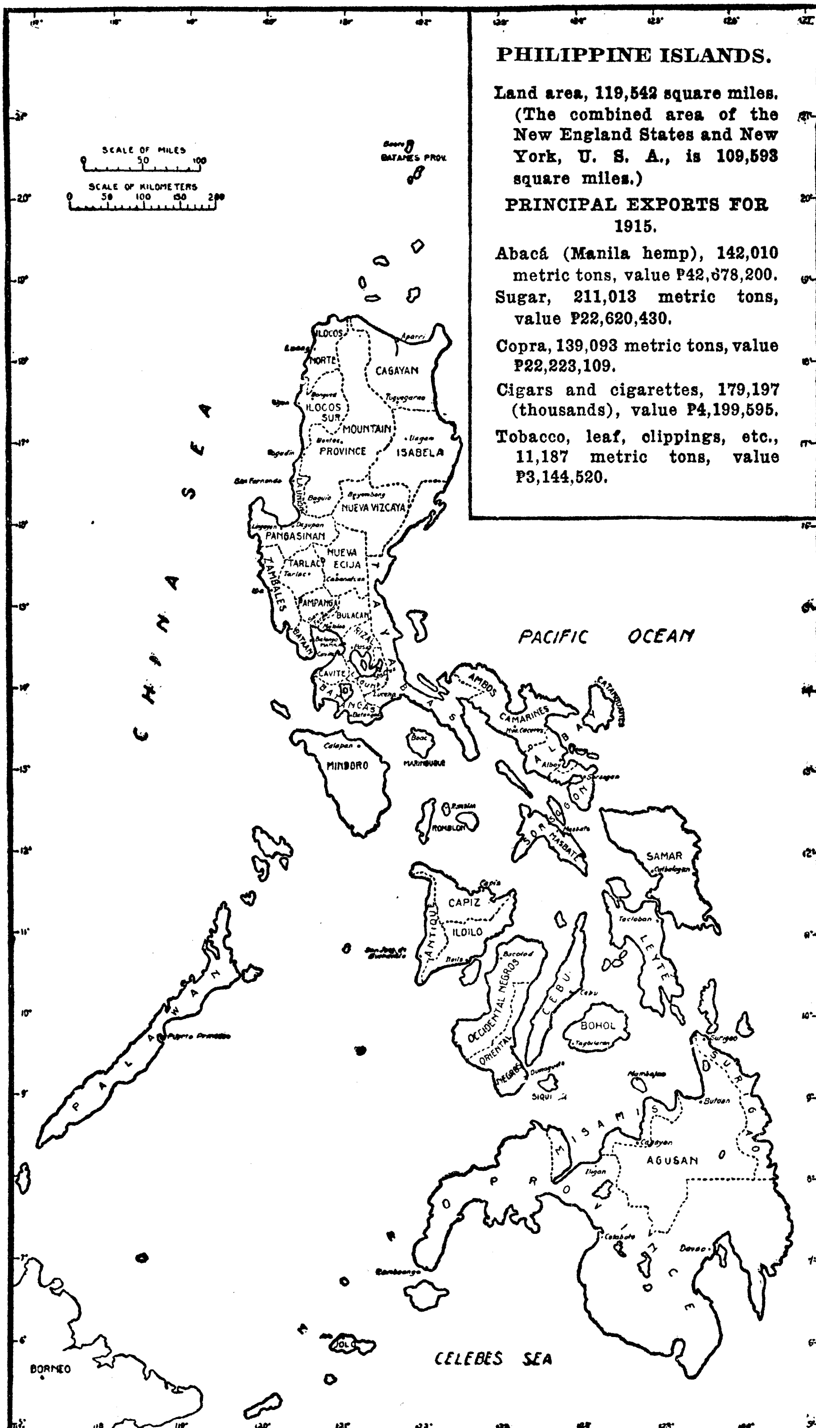
PHILIPPINE ISLANDS.
Land area, 119,542 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1915.
Abacá (Manila hemp), 142,010 metric tons, value ₱42,678,200.
Sugar, 211,013 metric tons, value ₱22,620,430.
Copra, 139,093 metric tons, value ₱22,223,109.
Cigars and cigarettes, 179,197 (thousands), value ₱4,199,595.
Tobacco, leaf, clippings, etc., 11,187 metric tons, value ₱3,144,520.
SCALE OF MILES
0 50 100
SCALE OF KILOMETERS
0 50 100 150 200
BATANES PROV.
CHINA SEA
PACIFIC OCEAN
CELEBES SEA
ILOCOS NORTE
CAGAYAN
Aparri
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
LA UNION
NUEVA VIZCAYA
PANGASINAN
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
BATAAN
RIZAL
CAVITE
BATANGAS
TAYABAS
AMBOS CAMARINES
ALBAY
SORSOGON
MINDORO
Calapan
MARINDUQUE
ROMBLON
MASBATE
SAMAR
CAPIZ
ILOILO
ANTIQUE
LEYTE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
SIQUIJOR
PALAWAN
Puerto Princesa
MISAMIS
SURIGAO
AGUSAN
MORO PROVINCE
Davao
Zamboanga
JOLO
BORNEO

(*a*) Luzon white sugar cane, 8 months old, Pampanga.

(*b*) Rice, Alabang Stock Farm.

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ERRATA.

Page 162. Plate II, (*a*), Kaong, *Arenga saccharifera.*
Page 200. Third paragraph, fourth line, ¶ Alsem.
Page 228. First line, *Zizyphus jujuba* Mill.
Page 231. First paragraph, last line, "laurel guava."
Page 253. Lines 20–22, *Cinnamomum.*
Page 253. Line 41, *Clausena lansium* Skeels. Wampi.
Page 253. Line 48, Coffee-Congo.
Page 254. Line 19, *Eugenia brasiliensis* Lam.
Page 256. Last line, *Zizyphus jujuba* Mill.
Page 257. First paragraph, last line, *Cubilia blancoi.*
Page 257. Second paragraph, fifth line, *Chrysophyllum cainito.*
Page 262. Second paragraph, fourth line, *Clitoria cajanifolia.*

THE PHILIPPINE

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EDITORIAL

The forests, the mineral deposits, the pearl fisheries, and other marine industries of the Philippine Islands, all contribute to the prosperity of the Archipelago, but agriculture and interdependent industries are and will always remain the dominant factor in the development of this country. Extended over a large area, mountainous, with elevations where the temperature occasionally drops to zero C. during the cold months of the year, with a highly diversified climate, generally very fertile soil, amply watered for purposes of irrigation, the Philippines are well adapted to the culture of a remarkable number of crop plants. Yet we are confronted by the no less remarkable fact that the value of the importations of food stuffs during 1915 was nearly 8 million dollars, or approximately 16 per cent of the total imports of the Archipelago. That this condition is not greatly on the mend is shown by the fact that ten years ago the import figures for food stuffs totaled a little more than $8\frac{1}{4}$ million dollars. It is, of course, true that some of the items that help to swell these figures cannot be produced in the Islands or they may be imported at a lower cost than that at which they could be produced here; but these items are comparatively insignificant and do not greatly affect the grand totals. Therefore, an inventory, so to speak, of the available resources of the Islands which might serve to alleviate this anomalous condition must necessarily be of interest.

Such a review was presented twelve years ago by Mr. F. Lamson-Scribner, the then Chief of the Bureau of Agriculture, in his descriptive list of the economic plants of the Philippines, which probably fairly accurately portrays the available agricultural knowledge of the Islands at that time.

Since the issue of that publication, much additional data relative to Philippine economics have been accumulated and the number of food plants, particularly fruits, has been increased very considerably, partly by the discovery of hitherto unrecorded, useful indigenous species, and partly through the introduction of exotic plants. It has, therefore, seemed desirable to prepare another list of food plants in the Philippines, such as appears in this number of the REVIEW, which, it is hoped, will assist in calling attention to the wealth of the agricultural flora of the Islands, and stimulate our agriculturists to greater efforts toward a fuller and broader utilization of all agricultural resources of the Archipelago.

THE FOOD PLANTS OF THE PHILIPPINES.

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

INTRODUCTION.

The Philippine Islands, lying between the Pacific Ocean and the China Sea, extend almost due north and south from Formosa to Borneo and the Moluccas, covering about 700 miles of longitude and 1,000 miles of latitude (4.40° to 20° north latitude and 116.40° to 126.30° east longitude). The Archipelago includes 3,141 islands with a land area of 119,542 square miles and has a population of about 8 million inhabitants.

The Philippines are of volcanic origin and the topography is characterized by a broken surface with more or less rugged mountains in all the larger islands. Between the mountain ranges lie several rich, level valleys, where the land is eminently well adapted to rice, corn, sugar cane, tobacco, abacá (manila hemp), and coconuts. In the higher elevations there is land suited to Arabian coffee, tea, and cinchona; in medium and low altitudes there are large areas adapted to the blight-resistant coffees. Good rubber land is found in Mindanao and adjacent islands to the east.

The climate is mild and free from extremes, though there is naturally considerable variation depending upon the altitude. According to the Director of the Weather Bureau, the Philippines have a mean annual precipitation of 2,400 millimeters, with an average precipitation of 1,300 millimeters in the driest, and of 3,900 millimeters in the rainiest, region of any considerable size. Excepting the Island of Cebu and the northern and western coasts of Mindanao and the Jolo group, the average rainfall is below 2,000 millimeters; all the northern, eastern, and western coasts receive an annual mean rainfall of above 2,000. In the low altitudes in the interior of the larger islands the precipitation seldom reaches 2,000, while in the highlands above 200 meters it ranges between 2,000 and 3,000 with a maximum of 4,000 millimeters in the Benguet Plateau in northern Luzon, which has an altitude of 1,400 meters. In certain sections of the eastern and southeastern coasts of Luzon, eastern Samar, and northeastern Mindanao, the rainfall averages about 3,000 millimeters. There are no large, especially dry regions in the interior of the greater islands, nor are there long periods of extraordinary drought.

Rice, abacá, coconuts, sugar, corn, and tobacco are the six principal crops of the Archipelago; but aside from the plants

from which these crops are obtained the Philippines have a remarkably large number of species of economic plants that are adapted to the soil and climate, among which the food plants, hereinafter enumerated, occupy a prominent place. Planted in those localities to which they are suited, grown in sufficient quantities, and intelligently cultivated, these plants would not only supply every human need for plant food in the Archipelago, but they would leave a large surplus for export. Yet it is a remarkable fact that the Philippines import large quantities of foodstuffs annually, chief among which is rice, and also cacao, coffee, dried legumes, potatoes, onions, starch, canned fruits and vegetables, and even fresh vegetables and fruits that could readily be grown in the Islands.

This situation, which cannot be viewed as anything but deplorable, is perhaps best illustrated in the import figures of foodstuffs for the past calendar year, as shown in the table below, in which also appear the importations of foodstuffs for the fiscal year ending 1905. It is worthy of note that the importation of rice dropped from a value of $10,061,323 in 1903 and $11,548,814 in 1904 to $7,456,738 in 1905. Flour and other articles that cannot be produced in the Philippines are not included in the table, with the exception of certain preserved and fresh fruits and vegetables that could not be separated, but these amounts are relatively insignificant and do not materially alter the total figures.

In this connection it should be stated that the sugar exports have risen from $4,977,026 in 1905 to $11,310,215 in 1915, copra from $2,095,352 to $11,111,500, to which latter figure may be added $2,820,500 for coconut oil. The abacá (manila hemp) exports for 1905 were $22,146,241 as compared with $21,339,600 for 1915, to which latter figure may be added knotted abacá to the amount of $305,746.

Importations of foodstuffs into the Philippines.

Article.	1905	1915
Beans, dried	----------	$76,586
Cacao	$149,656	204,742
Coffee	79,054	242,390
Corn	1,716	----------
Fruits, fresh, other than citrus	----------	109,637
Fruits, citrus	----------	38,142
Nuts	63,613	85,485
Peanuts	----------	59,319
Rice	7,456,738	6,224,275
Spices	14,686	33,245
Tea	37,957	74,483
Vegetables, fresh	----------	344,545
Vegetables, all kinds	514,511	----------
Total	8,325,102	7,992,853

To the 1915 import figures might be added starch, imported to the value of $67,789; refined sugar, $192,482; molasses, $37,349; and peanut oil, $62,238.

Without including the last four items, estimating the Philippine population at 8 millions in round figures, there is then an annual tax of about $1 for each man, woman, and child for imported foodstuffs that might be produced in the Philippines. Beyond keeping pace with the increase in population, our production of foodstuffs for home consumption does not appear to have increased very materially during the last ten-year period. To put the situation in another way, the importation of foodstuffs, possible of production at home, absorbed the major amount received for the sugar exported ($11,310,215) during 1915, leaving a balance in our favor of this item of only a trifle more than 3¼ million dollars.

A discussion of the various factors that contribute to these conditions is not within the scope of this paper. Suffice it to say, that with a better organized agriculture there should be little or no trouble in eliminating most of the minor items in imported foodstuffs, although until after the construction of extensive irrigation works which would make possible the successive cropping of the land during both the dry and wet period, there is little hope for improvement in this unfortunate situation relative to rice, the principal cereal of the Archipelago. Limiting ourselves to the products from the other plants hereinafter enumerated, with a proper development of our agricultural industries, the Philippines, in addition to being self-supporting agriculturally and multiplying the sugar and copra exports, should be able to export coffee, starch, and pilis in increasingly large quantities, and also rice, corn, and peanuts, aside from working up a thriving export trade in fresh and preserved fruits. There are no indications that tea and cacao will figure in the Philippine exports in the near future; and whether or not Philippine-grown maté could compete with the forest product of Paraguay and southern Brazil is debatable, should the use of this beverage spread like that of tea and coffee. In the meantime it is of interest to record that this plant, introduced within the last fifteen years, seems perfectly at home in the Philippines. Properly handled, there would appear to be no reason why some of the spices, such as pepper, cinnamon, and vanilla, should not be profitable.

The starting of such a specialized industry as cinchona growing is scarcely to be recommended until the basic agricutural industries are better developed; but in this connection it may

be stated that the Philippines imported in 1915 quinine to the value of $22,500 and that the United States is one of the largest importers of cinchona products in the world.

While the Philippines have not given the world any of the major plants of subsistence, yet they have made, or rather will make, a notable contribution in the pili, little known at present, but unquestionably destined to rank with the almond and Brazil nut in the world's trade. The cubili is another nut of exceptional eating qualities. Among the fruits, the marang, the bauno, and perhaps also the still unclassified tabú, are likely to attain prominence; the calpi is a valuable addition to the citrus fruits of Philippine origin. That it is only a question of time when the tongo will be extensively cultivated, no one doubts who has had the opportunity to sample the best varieties of this excellent vegetable.

The large number of species of the genus *Rubus* with edible fruits is worthy of attention, not so much for their value as fruits, though those of at least two species are of excellent flavor, as for their possible utilization in plant-breeding work for hybridization with their temperate relatives, with a view of obtaining a superior hybrid fruit adapted to the highlands and at least the medium elevations. The presence of four distinct, edible-fruited rattans is worthy of notice, as well as the occurrence of 9 Eugenias and 5 species of the genus *Garcinia.* Not less than 624 distinct rice varieties are known in the Archipelago. Among the lower forms of plant life, the number of edible algae and fungi is considerable, and the list will unquestionably be extended with a better knowledge of these plants. According to our present knowledge, not including the 20 species of algae and fungi, the Philippines have 93 species of native alimentary plants, a not inconsiderable contribution to the world's food plants. Altogether the list includes 368 species, of which 128 appear in Part I and 240 in Part II.

It is worthy of notice that the culture of a number of our best fruit trees, for instance the breadfruit, marang, and bauno, is extremely localized and confined to a few small districts or a limited number of trees, while in other sections equally well adapted to them they are entirely unknown, although in the Tropics this is not peculiar to the Philippines. A perusal of this paper by anyone familiar with plant life in the Archipelago will serve to emphasize this condition, and to show to what an almost culpable degree the dissemination of several of our more valuable fruits has been neglected, and how much remains to be accomplished in this respect.

Of the introduced and well-established species of tropical fruits the coconut, banana, mango, mandarin, chico, lanzon, and papaya are the most important, as are the camote, ubi and gabi, mungo, and cucurbitaceous plants among the vegetables.

The more notable plant introductions made since 1900 include many foreign varieties of sugar cane, camote, yautia, and cowpea, as well as the blight-resistant species of *Coffea*, Liberian coffee excepted, the standard commercial pineapple varieties, many of the standard citrus fruits, and several varieties of the muscadine grape and the avocado. Here may also be mentioned the Brazil nut, maté, cherimoya, and vanilla.

Broadly speaking, plants in the Tropics may be segregated into three groups: (1) Those that succeed where the wet and dry seasons are marked and distinct, with a prolonged dry period of several months; (2) those plants that require a relatively high degree of atmospherical humidity, and, if not an excessively large annual precipitation, at least a rainfall evenly distributed throughout the year with no long dry periods; (3) those species which do not thrive at the lower levels, but which, aside from other requirements, also demand a certain elevation in order to succeed.

Altitude and, consequently, temperature considered as a factor in relation to the climatic adaptability of a certain region to plant life, the Philippines may be divided into three zones: (1) The hot and low zone, from sea level to an elevation of 600 meters; (2) the zone of medium elevation, ranging from 600 to 1,200 meters; (3) the subtropical zone, above an altitude of 1,200 meters. These figures should, of course, not be considered in the absolute sense since the change of temperature in one zone to another naturally is gradual according to the rise or fall of the elevation. Then, too, the exposure and precipitation are also factors that must be taken into consideration.

Therefore, in addition to investigating the fertility and texture of the land, market conditions, transportation facilities, and availability of labor, the climate and elevation of the locality in question should be carefully considered in relation to the requirements of the prospective crop, before an investment is made, in order to avoid financial loss.

Generally speaking, the tropical agronomic crop plants and vegetables are planted at the beginning of the rainy period, while the temperate ones succeed best if the seed is sown with the advent of or during the dry season.

A list like the one under consideration necessarily can never be made quite complete. However, the exploration work in the

Archipelago for native food plants has been pushed with sufficient vigor within the last five years to warrant the belief that most native plants of average merit have now been brought to light. Later additions of note are therefore likely to be introductions from aboard rather than species indigenous to the Philippines. In this connection it may be well to mention the fact that the fruits that have been introduced within this century are in nearly all instances as yet confined to Government institutions and their fruits do not appear in the public markets. Nearly all the fruits hereinafter enumerated are being established at the Lamao experiment station; a large collection of economics, including also annual agronomic crop plants, is rapidly being established at the College of Agriculture, University of the Philippines, Los Baños, Laguna. With the development of the new introductions in these collections, material in quantity will within a few years become available for wholesale dissemination throughout the Archipelago.

The Filipino in the humbler walks of life, in common with other people in Malaysia, employs in the preparation of food the tender parts, such as the leaves, flowers and petioles, of many plants that ordinarily are not so used, a custom which is likely to disappear with the spread of education. Such plants have not been included in this paper, which has been prepared with a view of calling attention to what may be considered the permanent food plants of the Philippines and their uses as such.

Naturally, a majority of the indigenous uncultivated fruits are unimportant as a source of food at present, and they have been included more because of their anticipated and potential rather than their present and actual value.

In order to have a permanent record of the recent plant immigrants, all species permanently introduced later than 1900 are preceded by (*) and plants imported since 1910 are referred to as "of recent introduction" or "recently introduced." "Of recent domestication" indicates that a species is not in cultivation at large, and that it has been included in the plant collection at the Lamao experiment station for observation and study not earlier than 1910. Those plants marked (†) are believed to be indigenous to the Philippines.

The numerous different dialectal names of a species have been a source of much confusion in the past, and the adoption of one universal vernacular name for one species throughout the entire Archipelago is much to be desired; it is hoped that this paper will assist in the realization of this much-needed reform.

Except in the case of the temperate annuals which have been

introduced under and are known by their names in English, and a few names of fruits that are becoming well known, such as the orange, pineapple, mandarin, etc., native names have been retained as standard vernacular names, because of being shorter, more distinctive, and in most instances more attractive and euphonious than many names imposed upon tropical plants in English, which are often cumbersome, or convey a wrong impression of the plant or fruit in question.

Similarly, in the case of introduced species, for the same reason it has seemed best to introduce these to the public under their foreign names rather than under such designations as "hog plum," "alligator pear," "alligator apple," "wood apple," "Barbados cherry," "Ceylon gooseberry," "ground cherry," "monkey jack," "monkey peach," "governors plum," etc.

In some instances, where the plants had no popular name or where the name seemed too long and cumbersome for popular use, a derivation of the generic or specific name, or an abbreviation of the original name, or of the name of its source of origin, has been adopted as the vernacular name. In other words, while some of the selections may seem arbitrary, convenience has been the primary consideration in the adoption of standard names.

The following abbreviations are used to indicate the principal Philippine dialects to which the names, as far as known, belong: B., Bicol; Ib., Ibanag; Il., Ilocano; M., Moro; Mt., Mountain Province; P., Pampanga; Pa., Pangasinan; Sp., Spanish; Sp.-F., Spanish-Filipino; T., Tagalog; V., Visayan; Z., Zambales. Perhaps it should be mentioned that several of the minor dialects spoken there are included under the term Mountain Province, as it has not been considered necessary to distinguish them separately in a paper of this character. Nor are the scattered names in the several other unimportant dialects indicated.

A varietal name, of rice or of the banana, for instance, should, of course, be looked for in the alphabetical lists of those respective plants and not in the general list.

For convenient reference, the list has been divided into two parts: (I) Containing the agronomic crop plants, vegetables, algae and fungi, those used in seasoning or as condiments, and miscellaneous plants that are a source of foodstuffs, such as the sago palm, kaong, and nipa; and (II) the fruits, spices, and beverage plants. At the end of each part there is an index by species.

The information relative to the temperate vegetables is based largely upon data accumulated at the Trinidad experiment station, Baguio, Benguet, the Singalong experiment station, Manila, and

the Lamao experiment station, Bataan. The list of banana names has been arranged from papers by Mr. O. W. Barrett, formerly chief of the division of horticulture of this Bureau, which were previously published in this Review.

In addition to the data otherwise gathered by the writer, the compilation of the native plant names has been made after an examination of the herbarium of the Bureau of Science. A number of names in Bicol have been added through the courtesy of Mr. E. E. Schneider, Bureau of Forestry; the Dictionary of the Native Plant Names of the Philippine Islands by Mr. E. D. Merrill has also been consulted.

Acknowledgement is also made to Mr. Silverio Apostol, agricultural inspector, for the data relative to rice and for the preparation of the list of the rice varieties, and to Mr. C. W. Hines, station superintendent, for the list of sugar-cane varieties and information relative to yield. The statistics relative to the principal crops have been furnished by Mr. Antonio Peña, superintendent of statistics, all of this Bureau.

Mr. E. D. Merrill, botanist, Bureau of Science, has identified numerous plants collected by the writer in the course of gathering material for this manuscript, furnished all the information relative to the algae and much of that relative to the fungi, and during the examination of the herbarium of the Bureau of Science gave the writer many suggestions that have added to the value of the paper. The late Mr. W. S. Lyon furnished the information relative to the introduction of several species. The descriptions of the fungi have been adapted from Bulletin No. 28, Bureau of Government Laboratories, by Dr. E. B. Copeland, Dean of the College of Agriculture, University of the Philippines.

I.

VEGETABLES AND AGRONOMIC AND MISCELLANEOUS PLANTS.

Aba, Mt. See Gabi.
Abálong, V. See Gabi.
Abukay, Il. See Adlay.

Adlay, V. *Coix lachryma-jobi* L.

A coarse, annual grass 1 to 2 meters high, with hard roundish grains, of wide distribution, but rarely cultivated as a grain in the Philippine Islands. In this variety, Ilas, Il., *C. lachryma-jobi* var. *mayuen* Stapf, the covering of the grain is not as hard as in the ordinary adlay, which is commonly used for necklaces, etc. While not one of the very important cereals, it is cultivated to a considerable extent in India, Indo-China, Japan, and China. It is unusually rich in protein, with a greater fat content than most cereals. Succeeds well from sea level to an altitude of 1,200 meters.

Agagay, Ib. See Adlay.
Ágbo, Ib. See Sugar cane.
Agboy, Pa. See Turmeric.
Agdá, Mt. See Adlay.
Aggey, Mt. See Adlay.
Aglay, B. See Adlay.
Agoat, Mt. See Sitao.
Ajo, Sp. See Garlic.
Ajos, V. See Garlic.

†ALGAE. See *Algae.*

A group of plants among the lowest forms of plant life, inhabiting fresh and salt water, the latter commonly known as sea weeds. The fresh-water algae are of no importance as a source of human food in the Philippines, but there are several species of salt-water algae that are eaten quite extensively, either fresh, as a salad, cooked as a vegetable, but chiefly in the manufacture of guláman, a gelatinlike sweet meat, very popular among the Filipinos, prepared by boiling the algae with sugar and various spices.

The two most common forms in Manila are *Aghardiella* sp. and *Gracilaria conferoides* Grev., both known in the vernacular as guláman. Other edible species are cauát-cauát, Il., *Chaetomorpha crassa* Kütz.; pupú-lo, Il., *Codium tenue* Kütz.; *Entero-*

morpha intestinalis L., rupruppúue, Il., *Eucheuma spinosum* Ag.; susuéldot-baybay, Il., *Gracilaria crassa* Harv.; canót-canót, Il., *G. eucheumoides* Harv.; guráman, Il., *G. lichenoides* Grev.; báris-báris Il., *Liagora cheyneana* Harv.; gamét, Il., *Halymenia formosa* Harv.; and arágan, Il., *Sargassum siliquosum* J. Ag. To these will undoubtedly be added several other species as data are being collected.

Alimodias, B. See Adlay.
Alugbáti, V. See Libáto.
Amale, Ib. See Seguidilla.
Amargóso, B., Sp.-F. See Apalia.
Ambolong, V. See sago palm.
Ampaláya, T. See Apalia.
Ampalea, T, See Apalia.
Amparia, B. See Apalia.
Angai, P. See Turmeric.
Aníbung, Pa. See Kaong.
Anipa, Ib. See Nipa.

ANIPÁY, V. *Phaseolus calcaratus* Roxb.

An annual, twining herb, native of India, with long, slender pods, containing variously colored edible beans. Succeeds well from sea level to at least an elevation of 1,200 meters. Of wide distribution, but is cultivated sporadically only and is of practically no importance.

Anis, Sp. See Fennel.
Anto, V. See Oroy.
Aono-o, V. See Bamboo.
Apagi, Mt. See Adlay.
Apaláya, T. See Apalia.

APALIA, P. *Momordica charantia* L.

An annual, herbaceous, climbing vine of moderately vigorous growth, probably native of tropical Asia, in general cultivation throughout the Archipelago. The fruit is oblong, cylindric, tapering at both ends, ribbed, tuberculate, greenish, and very bitter. The fruit and tender growth are boiled and eaten with meat and vinegar by the Filipinos. The plant should be trained over a trellis.

Apgaki, Mt. See Adiay.
Apicac, Mt. See Patani.
Apio, Sp. See Celery.
Apípi. See Gábi.
Ápon, T. See Oroy.

APULID, B., T. *Eleocharis tuberosa* Schultes (?)

A perennial sedge, native of India and eastward, with small, dark-colored tubers 1 to 1.5 centimeters in diameter, growing

in swamps or flooded rice fields. Of local occurrence and limited production. The tubers are eaten, boiled.

Apúlit, T. See Apúlid.
†**Arágan**, Il., *Sargassum siliquosum* J. Ag. See Algae.

ARORO, T., V. *Maranta arundinacea* L.

A perennial herb, cultivated as an annual, native of tropical America, rarely exceeding 80 centimeters in height, with cylindrical, tapering, fleshy rootstocks, 12 or more centimeters in length, from which the arrowroot starch of commerce is obtained. Of fairly general distribution, but rarely cultivated, and here of no commercial importance. The roots contain 19 per cent of starch.

Arourou, Sp.-F. See Aroro.
Arroz, Sp. See Rice.
Arte, Mt. See Cadios.

ASPARAGUS. *Asparagus officinalis* L.

A perennial, erect herb indigenous to Asia and Europe, about 1 to 1.5 meters tall, with fleshy rootstock, cultivated for the young, tender shoots. While the plant makes a good growth even at sea level, for reasonably good results as a vegetable it requires here an altitude of 1,200 meters.

Atakei, Mt. See Adlay.
Attacay, Il. See Adlay.
Awatan, Mt. See Sitao.
Bacao, Ib. See Corn.
Badíang. See Gábi.
Bagácan, V. See Boho.
Bagacay, V. See Boho.
Bagáng, Ib. See Oroy.
Bagatay, Ib. See Buri.
Baglao, M., V. See Batao.
Bagong̃, B. See Oroy.
Bagotbat, V. See Kaong.
Bágsang, V. See Sago palm.
Baguang, B. See Upo.
Báhi, V. See Kaong.
Baino, T. See Lotus.
Bakwen, Mt. See Patani.
Balangay, V. See Cassava.
Balantácan, Pa. See Adlay.
Balatong, Il., V. See Mungo.
Bálong-luyon, P. See Buri.
Balúnggay, V. See Malungay.

BAMBOO. *Bambusa blumeana* Schultes f.

A treelike, cultivated or naturalized grass, attaining a height of 10 to 20 meters, of wide distribution in the Archipelago; the

common timber bamboo for construction. The young, tender shoots are boiled and eaten as a vegetable.

While the above-mentioned one is the species principally so employed, there are several other species that are also eaten, such as lopa, B. *cornuta;* bolinao, B. *vulgaris;* boho, *Schizostachyum mucronatum,* and other species of the last-mentioned genus and also of the genera *Dendrocalamus* and *Gigantochloa.*

Bánag, Il. See Garlic.
Bánang, Il. See Garlic.
Bánga. See Buri.
Báoang, V. See Garlic.
Barac, V. See Turmeric.
†**Báris-báris**, Il. *Liagora cheyneana* Harv. See Algae.
Báru. See Kaong.
Batacán, V. See Bamboo.
Bátad, B., V. See Sorghum.
Batal, B. See Sorghum.

BATAO, B., T., V. *Dolichos lablab* L.

An annual, twining vine of vigorous growth and of general distribution, native of the Old World Tropics. Grown on a trellis and cultivated for its edible beans. There are several varieties, distinguished chiefly by the coloration of the plants and the beans.

Batbat, V. See Kaong.
Baugin, P. See Bamboo.
Báwang, B., T. See Garlic.
Bay, Ib. See Aroró.
Bayancán. See Sapang.

BEAN. *Phaseolus vulgaris* DC.

An annual herb, commonly grown for its tender pods, which are picked and eaten immature as "string beans;" it has also been demonstrated that the beans may be successfully grown and dried during the dry season. The following varieties have been found the most successful: Early Mohawk, Dwarf Horticultural, Round Yellow, Wardwell's Kidney Wax, Black Valentine, White Wax, and Canadian Wonder. Succeeds well at all elevations. (Plate IV, *a.*)

BEET. *Beta vulgaris* Mog.

A biennial herb, grown as an annual for its red, succulent, fleshy roots, native of western Europe. The leaves may be eaten like turnip greens. May be grown at sea level, but succeeds best at and above an elevation of 600 meters. Here rarely cultivated.

Béhen. See Malungay.
Berengena, Sp. See Eggplant.

Bicacao, Il. See Boróna.
Bigá, B., V. See Gábi.
Binanbáng, T. See Rice.
Binticay, B. See Adlay.
Biríngai, T. See Bean.
Biriñgi, T. See Bean.
Bocaui, T. See Boho.
†**Boho**, T. *Schisostachyum lumampao* Merr. See Bamboo.
Boláhan, T. See Rice.
Bóligan, Mt. See Seguidilla.

BOLINÁO, V. *Bambusa vulgaris* Schrad.

An unarmed bamboo of erect growth, attaining a height of 6 to 15 meters, the tender growths of which are boiled and eaten as a vegetable. Native of China, and cultivated in India, Burma, the West Indies, and Central America, and other regions in the Tropics in both hemispheres. Widely distributed in the Philippines. (See Bamboo.)

Bolot, V. See Tongo.
Booan, Mt. See Calonay.
Boqa, Il. See Tongo.
Borírau, V. See Bolinao.

BORÓNA, P. *Setaria italica* Beauv.

An annual cereal of rapid growth, 1 to 1.5 meters high. Of rather wide distribution, but sparingly cultivated, chiefly among the Igorots in the highlands of northern Luzon. Succeeds from sea level up to 2,000 meters.

Borot, V. See Tongo.

BRUSSELS SPROUTS. *Brassica oleracea* var. *gemmifera* Hort.

An herbaceous biennial, cultivated as an annual for the small "heads" on the stem. Native of Europe. Not common in cultivation. For the best results, it should be grown at an elevation of not less than 1,200 meters.

Bucácao, Il. See Boróna.
Búlai, T. See Batao.
Bulí, T. See Buri.
Buloy, T. See Quiroi.
Búlu, V. See Boho.
Bulugian, Mt. See Seguidilla.
Bungkokan, B. See Gabi.

BURI, V. *Corypha elata* Roxb.

A palm attaining a height of 20 meters, with stout trunk and fan-shaped leaves, native of India to Malaysia. Starch is obtained from the trunk like in the sago palm; sugar, sirup, vinegar, and wine from the sap of the tender inflorescence; and excellent preserves are made from the immature seeds boiled

(*a*) Kaong, *Arenga sacharifera*. Silang, Cavite.

(*b*) Sago palms, *Metroxylon sagu*, in the Island of Cebu.

PLATE III.

The nipa, *Nypa fruticans*. Bulacan.

in sugar. Of wide distribution, but of little economic importance as a food plant.

Burobayóco, B. See Adlay.
Buslig, Il. See Apulid.
Bûting. See Beans.
Butínga, T. See Bean.
Cabatiti, Il. See Patola.

CABBAGE. *Brassica oleracea* L.

A biennial herb, grown as an annual for its fleshy, succulent leaves, which form a "head;" native of Europe. It makes a fair growth even at medium elevations, but does not give the best results below an altitude of 900 meters. At and above this elevation the growth is very satisfactory. Not extensively cultivated.

Cabeza de negrito Sp.-F. See Apulid.
Caboloan, B. See Bolinao.
Cabo-negro, Sp.-F. See Kaong.
Cábul, V. See Cucumber.

†**CABUTI**, T. *Agaricineae.*

A name applied in a general way to a group of fleshy, umbrella, top, or finger shaped, round or wrinkled plants, rarely more than 15 millimeters high, of various colors and rapid growth, many species of which are collected and eaten as a vegetable, boiled or fried, commonly in the fresh state, but also dried and stored away for future use; known in English as mushrooms or toadstools. There are also several species of poisonous cabuti, which are quite similar to the edible ones, and great care should therefore be exercised in collecting cabuti in order to avoid poisoning. No attempt should be made to collect the edible cabuti with the aid of the short descriptions given hereinafter. The edible forms are usually well recognized in their respective localities by the Filipinos. One unidentified species is cultivated in Pampanga Province. In the Mountain Province certain unidentified forms are quite extensively collected by the Filipinos, dried, and stored away.

Among the larger species are the following: *Agaricus boltoni* Copel., a white-fleshed, umbrella-shaped, well-flavored cabuti, 8 to 15 centimeters high and 10 to 15 centimeters wide, found in sunny pastures; *Agaricus merrillii* Copel., a whitish to brownish plant up to 10 centimeters high and of the same width; *Lepiota chlorospora* Copel., a fleshy, round, bell to umbrella shaped, brown cabuti, 4 centimeters high and 8 centimeters wide; *Lepiota elata* Copel., a brownish, conical to flattened cabuti, 5 to 8 centimeters high and 4 to 6 centimeters in diameter; *Lepiota*

manilensis Copel., a bell-shaped to conical, finally flat, brownish plant up to 10 centimeters high, 5 to 9 centimeters in diameter, of excellent flavor; *Panaeolus panaiense* Copel., a conical tawny plant up to 12 centimeters high and 7 centimeters wide; *Volvaria esculenta* Bres., this cabuti grows in great profusion on the decaying waste in the abacá districts, and is the most important edible cabuti in the Philippines. It is of excellent flavor.

The following species are also edible: *Lepiota candida* Copel, *Coprinus ater* Copel, *Coprinus confertus* Copel, *Lycoperdon todayense* Copel.

In addition to the above species there are probably many other edible mushrooms in the Philippines, as yet undescribed.

Cacahuete, Sp. See Peanut.
Cacauáte, T. See Peanut.

CADIOS, B., V. *Cajanus indicus* Spreng.

A shrubby herb, native to southeastern Asia and Polynesia, 1 to 2 meters tall, usually grown as an annual and fairly generally cultivated for its edible beans which may be used like the bean, immature or ripe and dried. Of wide distribution. The "native" varieties are all black seeded; white-seeded varieties have recently been introduced.

Cagnóis, T. See Cadios.
Cagyós. See Cadios.
Calabáza, Sp. See Pumpkin.
Calabazang, T. See Squash.
Calamismis, T. See Seguidilla.
Calavága, V. See Turmeric.
Caldis, Mt. See Cadios.
Calígay, T. See Malungay.
Callos, M. See Cadios.

CALONAY, Il. *Amaranthus viridis* L.

An erect, cosmopolitan annual herb about 50 centimeters tall, of universal distribution, sometimes cultivated. The tender leaves are eaten like spinach.

A number of other species of *Amaranthus* are similarly used, but are not cultivated and of no importance.

Calúbay, V. See Upo.
Calugay, V. See Malungay.
Calúngai, B. See Malungay.
Calút, P., T., Z. See Nami.
Camalóñgay, T., V. See Malungay.
Camalúñgue, P. See Malungay.
Camalúson, V. See Seguidilla.
Camátis, B., Il., T., V. See Tomato.

CAMOTE, Sp.-F. *Ipomoea batatus* L.

A perennial, creeping, spreading, herbaceous vine, native of tropical America, cultivated as an annual for its starchy, fleshy, edible root, succeeding from sea level to well above 1,000 meters. Average starch content 20 per cent, with wide variation according to the variety, soil, and climate where grown. The most important root crop in the Philippines, of which many native and imported varieties are cultivated.

The following varieties are cultivated in the Mountain Province: Bacao, Balaan, Baygani, Batnat, Dulog, Guihang, Hiddanao, Oacal, Pahlong, Patoqui, Picnayan, Pucal. The following varieties are grown in other parts of the Philippines: Amorosa, Beriberi, Bumatus, Caagarao, Cabulan, Cahodo, Caigbao, Camiang, Canegro, Guinarosa, Inigcanto, Maragandang, Melakena, Montivideo, Sinamporado, Tinampay, Tinobagang, Quenodiapa.

Camoting cahóy, B., T., V. See Cassava.
Canábon, V. See Yabia.
Cancampilan, T. See Marutong.

CANCÓNG, B., P., T., V. *Ipomoea reptans* Poir.

A spreading, trailing vine, native of the Old World Tropics, growing in swampy land and shallow, stagnant water. Of wide distribution, but not cultivated. The tender leaves are boiled and eaten as greens.

Candól. V. See Condól.
Cánon, T. See Kaong.
†**Canót-canót**, Il., *Gracilaria eucheumoides* Harv. See Algae.
Caña boho, Sp.-F. See Boho.
Caña-dulce, Sp. See Sugar cane.
Capelan, T. See Anípay.

CARAWAY. *Carum carui* L.

A biennial herb about 50 centimeters high, grown for its aromatic seeds which are used in confectionery. Sparsely distributed and rarely cultivated.

Cardis, Mt. See Cadios.

CARROT. *Daucus carota* L.

A biennial herb, cultivated as an annual for its fleshy root, but rarely grown; native of western Europe. Succeeds best at and above an elevation of 900 meters.

Casira. See Chile.

CASSAVA. *Manihot utilissima* Pohl.

A perennial, woody, erect herb of rapid growth, 2 to 3 meters tall, native of the American Tropics, cultivated as an annual

for its large roots from which starch is extracted. Of universal distribution, but of comparatively slight importance even locally. Average starch content 25 per cent with considerable varietal variation. Best adapted to low elevations, and light, friable soils.

Catígbi, B. See Adlay.
Catumbal. See Chile.
†**Cauát-cauát**, Il. *Chaetomorpha crassa* Kütz. See Algae.
Cauáyan, Il., T. (used in the generic sense for all bamboos). See Bamboo.
Cauáyan guid, Il. See Bamboo.
Cauáyan hobero, T. See Bolinao.
Cauáyan matinic, T. See Bamboo.
Cauáyan quíling, T. See Bolinao.
Cauáyan seitan, Il. See Bamboo.
Cauáyan totoo, T. See Bamboo.

CAULIFLOWER. *Brassica oleracea* var. *botrytis* DC.

A biennial herb, native of Europe, grown as an annual for its tender, succulent flower clusters, which are eaten as a vegetable in the immature stage, but very rarely cultivated. Does not succeed well below an elevation of 1,200 meters.

Cayos, V. See Nami.
Cebolla, Sp. See Onion.

CELERY. *Apium graveolens* L.

A biennial herb, indigenous to Europe and southeastern Asia, grown as an annual for the leaf stalks, which blanched, are eaten raw as a vegetable or cooked in soup. May be grown at medium elevations, but for the best success should be planted at or above an altitude of 1,200 meters. Rarely cultivated.

Chalote, Sp. See Shallot.
Chicharo, Sp. See Pea.

CHILE, Sp. *Capsicum frutescens* L.

An erect, shrubby, perennial herb, native of tropical America, 0.6 to 1.0 meter tall, of universal distribution, and commonly cultivated for its pungent fruits, which are used for flavoring.

Chíleng-bundoc, T. See Chíle.
Chíle-picante, Sp.-F. See Chíle.
Cibocibollasan, T. See Apulid.
Cobag, T. See Quirói.
Cohombro. See Cucumber.
Colchis, Mt. See Cadios.
Coldasan, B. See Adlay.
Colitis, T., V. See Calonay.
Colot, V. See Nami.

CONDOL, B., T., Sp. *Benincasa hispida* Cogn.

A cucurbitaceous, annual vine of general distribution, which is usually trained to grow on an arbor, but may also be grown

like the watermelon; believed to be a native of tropical Asia. The large melon-shaped fruits, nearly ripe, are eaten as a vegetable, boiled, and the mature peel, candied, is very acceptable. Adapted to medium and low elevations.

CORIANDER. *Coriandrum sativum* L.

An erect, annual herb, of south European origin, rarely cultivated, the leaves of which are used for seasoning soups and the seeds in confectionery. For altitudes of 600 meters and above.

CORN. *Zea mays* L.

A coarse, annual grass, 2 or more meters tall, of general distribution and cultivation, indigenous to tropical America. Rice excepted, the only cereal of importance in the Philippines. During 1915, 443,048 hectares were planted to corn, yielding 5,181,269 hectoliters of shelled corn valued at $8,033,829.

The following provinces lead in production of corn: Cebu, Oriental Negros, Isabela, Leyte, Cagayan, and Bohol.

Among the more prominent varieties are the following: Cebu Purple, Cebu White, Iloilo Yellow, Iloilo White, Laguna Yellow, Mexican June, Moro.

Sugar corn succeeds well and makes good-sized ears of good quality, but the growth of the plants is usually dwarf.

While it may be grown at higher altitudes corn succeeds best below an elevation of 1,200 meters.

Corót, Il., V. See Namí.

***COWPEA.** *Vigna catjang* Endl.

An erect or twining, annual herb of vigorous growth, becoming gradually cultivated throughout the Archipelago to a considerable extent. Probably native of China. The tender pods may be eaten as string beans, and mature, the seeds may be substituted for beans. One of the best all-around legumes for field culture. The "New Era" is by far the best variety with "Clay" a good second.

Cuchai, T. See Leek.
Cucubítan, P., T., V. See Pacupis.

CUCUMBER. *Cucumis sativus* L.

A trailing, herbaceous, annual vine of fairly wide distribution, native of India, and quite extensively cultivated, the immature fruits of which are sliced and eaten raw. The "India" is a variety especially adapted to low elevations.

Cudlasan, T. See Adlay.
Culantro, Sp. Coriander.

Culálas, P. See Turmeric.
Culiao, Il. See Turmeric.
Cunig, Il. See Turmeric.
Curagdá, P., V. See Pacupis.

***CURUBA.** *Sicana odorifera* Naud.

A cucurbitaceous, perennial, climbing vine attaining a length of 15 meters, indigenous to tropical America. The fruits are oblong, 25 to 35 centimeters long, and 7.5 centimeters in diameter, smooth, orange red, and pleasantly aromatic. Said to be excellent as a vegetable, immature, and ripe, to make a good preserve. Of recent introduction.

Cutacút, Mt. See Patani.
Dagmay, V. See Gábi.

†DAMPÁLIT, T. *Sesuvium portulacastrum* L.

A succulent prostrate herb growing along the seashore, occurring also on the south Atlantic Coast of the United States and the West Indies. The tender stems and leaves are boiled and eaten as greens. Not cultivated.

Dáoa, V. See Boróna.
Dava, T., V. See Boróna.
Decdecoc, Mt. See Peanut.
Diláo, T. See Turmeric.

DILL. *Anethum graveolens* L.

An herbaceous annual, native of South Europe, 0.6 to 1 meter high, cultivated for its aromatic leaves which are used for seasoning. Succeeds well at all elevations. Rarely cultivated.

Dóao, V. See Turmeric.
Dóol, Il., P., V. See Malungay.
Dulao, V. See Turmeric.
Dumali, T. See Rice.
Dumáo, B. See Adlay.
Ebus, Pa. See Buri.

EGGPLANT. *Solanum melongena* L.

An erect, herbaceous annual, probably native of the American Tropics, about 60 centimeters tall, with large, roundish-oblong to slender, cylindrical, purplish fruits, rarely above 20 centimeters long. Extensively cultivated; one of the most important vegetables in the Archipelago.

ENDIVE. *Cichorium endivia* L.

An annual herb, grown for its leaves which are eaten as a salad; rarely cultivated. Succeeds best at an elevation of and above 600 meters.

Enge, Pa. See Turmeric.

Espárrago, Sp. See Asparagus.

FENNEL. *Foeniculum vulgare.* Gaertn.

An herbaceous perennial, native of Europe, about 1 meter tall, of rather rare occurrence, the leaves of which are used as flavoring and the seeds in confectionery. Succeeds best at and above an elevation of 600 meters.

Ferns, edible. See Paco.
Fungi, edible. See Cabuti.

GÁBI, B., Ib., T., V. *Colocasia esculenta* Schott.

A perennial herb 0.75 to 1.25 meters tall, with large leaves, native of India, cultivated as an annual for its large, starchy tubers which are eaten like potatoes; the leaves, boiled, are also eaten. After the camote and ube, the third most important root crop in the Philippines. Usually grown on moist land or in stagnant, shallow water, but the quality of the tubers is greatly improved by growing the plant on well-drained land. Several varieties are recognized, among which the following are cultivated in the Mountain Province: Anghiao, Caguitguit, Lelin, Ohod, Mabbalat, Malicca, Tupoy. Average starch content 18 per cent, with considerable variation according to the variety.

Gábing-pola, B., T., V. See Gábi.
Gablos, T. See Gábi.
Gáby-sibóyas, T., V. See Gábi.
Galíang, B., V. See Gábi.
†**Gamét**, Il., *Halymenia formosa* Harv. See Algae.
Gandá, V. See Garlic.
Gandús, P., T., V. See Gábi.

GARLIC. *Allium sativum* L.

A perennial, bulbous herb, native of southern Europe, grown as an annual for its bulbs which are used for seasoning. Most extensively cultivated in Batangas. Quite widely distributed but elsewhere grown to a limited extent only.

Gattoc, Mt. See Camote.
Gauay, P., T., V. See Gábi.
Gayos, V. See Namí.

***GUAR.** *Cyamopsis psoralioides* DC.

An annual, erect herb, from 50 centimeters to over 2 meters high, of free growth and easy culture. The tender pods and the ripe seeds are used as a vegetable in India. For this purpose, the seed should be sown at the end of the rainy season. Adapted to low and medium elevations. Recently introduced, scarcely at all cultivated.

Guinatos, V. See Gábi.

Guláman, T. See Algae.
Gumbo. See Okra.
†**Guráman**, Il., *Gracilaria lichenoides* Grev. See Algae.
Hába, Sp. See Patani.
Habas cabayo, T. See Marutong.
Habichuela, Sp. See Bean.
Habioc, V. See Kaong.
Hála-hála, T. See Pacupis.
Hamtác, B., V. See Cowpea.
Haras, T. See Fennel.
Hibióc, V. See Kaong.
Hicamás, T. See Sincamá.
Hidióc, B., V. See Kaong.

HORSERADISH. *Cochlearia armoracia* L.

A perennial herb about 50 centimeters tall, native of eastern Europe, adapted to elevations of 900 meters or more, where it succeeds well, but is rarely cultivated. The fleshy, pungent roots, grated, are excellent for seasoning meat, etc.

Hothót, T. See Pacupis.
Humay, V. See Rice.
Ibióc, V. See Kaong.
Iddaya, Mt. See Shallot.
Idióc, B., V. See Kaong.
Igoc, V. See Kaong.
Ilaibáquir, Il. See Libáto.
Ilas, Il. See Adlay.
Iroc, T. See Kaong.
Itab, Mt. See Batao.
Kahelan, Mt. See Corn.
Kalabugao. See Adlay.
Kalauag, B. See Turmeric.

KALE. *Brassica oleracea* var. *acephala* DC.

A biennial herb, native of Europe, that succeeds well above an altitude of 900 meters. However, the edible portion is here so tough that the plant is not worth cultivating. Rarely grown.

Kamiging, B. See Tongo.

KAONG. *Arenga saccharifera* Labill.

A palm attaining a height of 12 meters, with fairly stout trunk and pinnate leaves, 6 to 8 meters long, native of India to Malaysia. Sago is extracted from the trunk, wine and palm sugar is obtained from the young inflorescence, and an excellent preserve is made from the immature seeds boiled in sugar. Of wide distribution at low and medium elevations, but of little economic importance (Pl. II, *a*.)

Kawayan, T. (used generically for all bamboos). See Bamboo.
Kawoat, Mt. See Sitao.

Kidis, Il. See Cadios.
Kitchis, Mt. See Cadios.

KOHLRABI. *Brassica oleracea* var. *caulo-rapa* Hort.

A biennial herb, cultivated as an annual for its fleshy, turnip-like stem, which is eaten like the turnip and rutabaga. Native of Europe. Succeeds well at an altitude of 1,200 meters, and has been reported to grow at medium to low elevations and there produce better than any other species of *Brassica.*

Labug, Il. See Borona.
Ladá, B. See Chile.
Lagvay, P., T., V. See Gábi.
Lam-uan, V. See Bamboo.
Lamudias, V. See Adlay.
Lamudio, T., V. See Caraway.
Lamúyo, T. See Rice.
Langa, Il. See Sesame.
Langdang, V. See Sago palm.
Lapni, Mt. See Camote.
Lára, P. See Chíle.
Lása, V. See Nipa.
Láso, V. See Garlic.
Lasóna, Il. See Onion.
Lastón, V. See Sitao.
Lasuna, T. See Sitao.
Latoy, V. See Sitao.
Lauas, T. See Pulao.
Lechuga, Sp. See Lettuce.

LEEK. *Allium porrum* L.

A perennial herb, indigenous to the Mediterranean countries, grown as an annual for its blanched stems and leaves, and used for flavoring or eaten raw. Rarely cultivated, and does not grow well below an altitude of 600 meters.

LETTUCE. *Lactuca sativa* L.

An herbaceous annual, grown for its succulent leaves which are eaten raw. Succeeds at all elevations, but gives the best results above an elevation of 900 meters. Quite generally cultivated.

LIBATO, T. *Basella rubra* L.

A trailing vine with tender, succulent leaves which are boiled and eaten like spinach, believed to be native of tropical Asia. Of fairly wide distribution, but cultivated to a limited extent only. The native variety is of poor quality; two very superior varieties, one green and one purple, have recently been introduced. Should be trained over a low trellis. For low and medium elevations.

Lima-lima, T., V. See Sapang.
Linza, B. See Gábi.
Lisangay, Z. See Turmeric.
Locdo, V. (a name applied in a generic sense to all ferns). See Paco.
Locto, Mt. (a name applied in the Mountain Province to both the camote and tongo).
Longe, Mt. See Sesame.
Lopa, Ib., *Bambusa cornuta* Mro. See Bamboo.

LOTUS. *Nelumbium speciosum* Willd.

A perennial, aquatic herb with large, round leaves and exceedingly attractive, pink, red, or white, large flowers, standing out of the water, the flower overtopping the leaves. The large seeds, of which several are contained in a cone-shaped capsule, are nutritious, of a good, nutty flavor eaten raw nearly mature, or roasted when ripe. Quite widely distributed but not cultivated. (Pl. V. *c.*)

Lumampáo, T. See Boho.
Lumbia, V. See Sago palm.
Lumbiag, M. See Sago palm.
Lumot or lumut. See Algae.
Lunas, V. See Bolinao.
Luñga. See Sesame.
Lutto, Ib. See Tongo.

†**LYON BEAN.** *Mucuna nivea* W. & A.

An annual, herbaceous, twining vine of vigorous growth with fleshy pods and grayish beans, of wide distribution in the Philippines, occurring also in India and eastward. Its chief value is for forage and as a cover crop, but the immature beans are also eaten like the patani. The yield is greatly increased by allowing the vines to run on poles or a trellis. Adapted to low and medium elevations. Utilized for human food to only a slight extent.

Magsalóro-ñga-dacú, V. See Panárien.
Magtambocao, V. See Marutong.
Maís, Sp. See Corn.
Malagay, T. See Malungay.
Malagquit, B., T. See Rice.
Malasincamas, T. See Marutong.
Malíñga, T. See Condol.
Malísa. See Chíle.
Malúgit, P., V. See Malungay.

MALUÑGAY, T., V. *Moringa oleifera* Lam.

A small tree, rarely more than 8 meters in height, of rapid growth and brittle wood; of general distribution. The tender pods and leaves are boiled and eaten.

Malúñgit, P., V. See Malungay.
Manggulasi. See Anípay.
Mani, Il., Sp.-F., V. See Peanut.
Margóso, T. See Apalia.
Marungay, Il. See Malungay.

MARUTONG. *Canavalia ensiformis* L.

A perennial, herbaceous vine, with large pods, 15 to 20 centimeters long, containing numerous, large white beans, which, in the tender, immature state, may be eaten like string beans. Used dry like beans, the beans should be soaked in cold water and be given an extra boiling in changed water in order to be palatable. Of wide distribution, but rarely cultivated. Not well adapted to high altitudes.

Mayay. See Nami.
Mijo, V. See Borόna.

MINT. *Mentha arvensis* L.

A prostrate, perennial herb, native of Europe and temperate Asia to China. Occurs semicultivated in many parts of the Philippines; grows at all altitudes, but flourishes best above an elevation of 1,000 meters. The leaves are used for flavoring.

Móngos, T. See Mungo.
Mostaza, Sp. See Mustard.

MUNGO, B., T., V. *Phaseolus aureus* Roxb.

An erect or semiclimbing, annual herb, native of India, rarely exceeding 50 centimeters in height, of fairly general cultivation and of considerable importance in the lowlands. There are at least three well recognized varieties, the variously colored seed of which are eaten like beans.

Mushroom. See Cabuti.

MUSTARD. *Brassica juncea* Coss.

An herbaceous annual, quite generally cultivated for its leaves which are eaten as "greens." Native of Asia. Succeeds well at all elevations.

†**NAMI**, T. *Dioscorea triphylla* L.

A spiny, twining vine with trifoliate leaves, and rather large, starchy, poisonous tubers, that are rendered edible by slicing and placing in running water for 36 to 48 hours. There are at least two distinct varieties in the Philippines, one with "hairy" and one with smooth tubers. Widely distributed but rarely cultivated. Averages 18 per cent in starch content with slight variations.

Namo, B. See Nami.
Nilómot, T. See Rice.

†**NIPA**, B., T., V. *Nypa fruticans* Wurmb.

A creeping palm with a stout, branching rootstock, and large leaves, 5 to 10 meters long, growing in saltwater swamps. Not cultivated. The sap is collected from the immature inflorescence and made principally into alcohol, and to a less extent into wine, vinegar, and sugar. A good preserve is made from the immature seeds boiled in sugar. (Pl. III.)

The nipa is believed to furnish the cheapest material in the world for the manufacture of sugar and alcohol, one hectare of nipa swamp being capable of producing 10,450 kilograms of sugar or 10,800 liters of alcohol. During 1914, 9,785,000 liters of alcohol were made from nipa sap.

Oaliding, Mt. See Patani.

***OKRA**. *Abelmoschus esculentus* Moench.

An annual herb about 1 meter or more tall, of general distribution and culture; grown for its edible seed pod, which is eaten boiled. Best adapted to low or medium elevations. Native of tropical Asia.

Onao, V. See Kaong.

ONION. *Allium cepa* L.

A perennial herb, native of Europe, cultivated as an annual for its fleshy bulbs which are used for seasoning meat, etc. Succeeds best at or above an elevation of 600 meters. Grown to a very limited extent.

Opo, B., T. See Úpo.
Oras, B. See Boho.
Orót, V. See Namí.

†**OROY**. V. *Amorphophallus campanulatus* Bl.

A perennial herb with a large roundish corm, somewhat flattened, up to 30 centimeters in diameter, and a large, usually solitary leaf, sometimes exceeding 1 meter in height, and a large malodorous flower. Before the leaf is expanded, the tender petiole, peeled and boiled, is eaten with meat and onions. In the raw state the corms contain oxalate of lime crystals, and it is doubtful whether the starch can be extracted to advantage commercially. Starch content variable, from 4.5 to 12 per cent.

Otong, Il. See Cowpea.

†**PACÓ**, B., P., T. *Athyrium esculentum* Copel.

A fern with a stout rootstock, 0.50 to frequently exceeding 1 meter in height. Of wide distribution, but not cultivated. The tender leaves are boiled and eaten like spinach.

The name pacó is also used to designate other edible ferns of which there are several of minor importance.

Pactiv, Mt. See Chile.

PACUPÍS, B., T. *Trichosanthes anguina* L.

A cucurbitaceous, annual, climbing herb, with long variegated fruits that, partly grown, are boiled and eaten. Of limited distribution. Should be grown on a trellis or arbor.

Pagda, Pa. See Malungay.
Pagi, Mt. See Rice.

†**PALAUAN**, V. *Cyrtosperma merkusii* Schott.

An aroid of exceedingly robust growth, from 1.5 to sometimes exceeding 3 meters in height, suited to moist, even swampy soils. The large, starchy rootstocks are used as food in time of scarcity. The plant is grown to a limited extent in the Visayas and southern Luzon. Starch content 7.5 per cent.

Paláy, T. Sp.-F. See Rice.
Palía, V. See Apalia.
Palias, V. See Adlay.
Pálla, T. See Apalia.
Pallag, Il. See Seguidilla.
Pal-lam, Il. See Seguidilla.
Pallang, Il. See Seguidilla.
Palut, Ib. See Chile.
Pamangquílon, V. See Oroy.
Panarién, Il. See Yabia.
Panas, B. See Adlay.
Pangas, P. See Turmeric.
Pannirien, Il. See Yabia.
Pañas, V. See Adlay.
Pápas, T. See Potato.
Papet, Mt. See Apalia.

†**PAQUÍT**, T. *Dioscorea luzonensis* Schauer.

An annual, twining, smooth vine, and slender, long tubers that are collected and eaten like the potato. Not cultivated.

Paray, V. See Rice.
Parda, Il. See Batao.
Pardaatap, Il. See Batao.
Paría, Ib., Il. See Apalia.
Paroi, B. See Rice.

PARSLEY. *Carum petroselinum* Benth. & Hook.

A biennial herb grown as an annual for its leaves, which are used for flavoring soups, etc. Succeeds at all elevations, but does best above an altitude of 900 meters. Not extensively cultivated.

PARSNIP. *Pastinaca sativa* L.

A biennial herb cultivated for its fleshy root which is boiled and eaten with meat, etc.; sparingly grown. Not successful below an elevation of 1,200 meters.

Parupagulung, B. See Seguidilla.
Pasingan, Ib. See Bamboo.
Pasitís, T. See Chíle.

PATÁNI, T., V. *Phaseolus lunatus* L.

A perennial, twining vine of vigorous growth, commonly cultivated as an annual, of wide distribution, and in general cultivation; grown on a trellis, arbor, or bamboo poles for support. Indigenous to tropical America. There are at least seven distinct "native" forms, of which the whiteseeded varieties are the best for culinary uses; the colored or variegated beans should be boiled and the water changed two to three times to render them wholesome.

Patáning-dágat, T. See Marutong.
Patáta, Sp. See Potato.

PATÓLA, B., P., V. *Luffa acutangula* Roxb.

An herbaceous, annual, climbing vine, grown on a trellis or arbor for its oblong, green, angled fruits which, immature, are boiled and eaten. Of wide distribution and universal cultivation.

PATOLA, B., T., V. *Luffa cylindrica* Roem.

Similar in appearance and uses to the above-described species, except that the fruits are cylindrical instead of angled. Like its congener it is universally cultivated.

Paua, Il. See Bamboo.
Pauid, T. See Nipa.

PEA. *Pisum sativum* L.

A climbing, tendril-bearing, annual herb, 0.5 to 1 meter tall; of European origin. While it may be grown at lower altitudes, for good results the pea should not be planted below an elevation of 600 meters; excellent yields are obtained at an altitude of 1,200 meters. Rarely cultivated.

PEANUT. *Arachis hypogaea* L.

An annual, spreading herb, believed to be a native of Brazil, cultivated for its oily seeds contained in pods ripening under the ground. The "nuts" are eaten roasted, and are frequently used to adulterate cocoa and chocolate; a valuble culinary oil is expressed from the seeds. The peanut is cultivated to a considerable extent, but is not sufficiently important to have warranted the collection of statistics as to area cultivated and yield and which are therefore not available.

*PECHAY, B., T. *Brassica petsai* Bly.

An annual Chinese herb, fairly extensively grown for its succulent leaves, which are boiled and eaten like spinach. May be grown at sea level, but does best at elevation above 600 meters.

Pepino, Sp. See Cucumber.

PEPPER. *Capsicum annum* L.

An herbaceous annual, native of the American Tropics, up to 50 centimeters tall, rather common in cultivation for its large, fleshy fruits which are eaten as a vegetable.

Perejil, Sp. See Parsley.
Piet, P. See Buri.
Pintaca, B. See Adlay.
Pocotpócot, P., V. See Pacupis.

POTATO. *Solanum tuberosum* L.

A perennial herb, cultivated as an annual for its starchy tubers; native of South America. Potatoes should not be planted below an elevation of 600 meters, and an altitude of 1,200 meters or above is more favorable for their development. Of local limited cultivation. Starch content, 18 per cent.

Potoc, T. See Apulid.
Póyas, B. See Adlay.
Pucopúcot, P., V. See Pacupis.
Puerro, Sp. See Leek.
Pugáhan, T. See Kaong.

PULÁO, T. *Castalia lotus* Tratt.

A perennial, aquatic herb about 1.5 meters high, growing in fresh-water lakes and stagnant water, the leaves and white, handsome, fragrant flowers floating on the water. The fleshy rhizomes are gathered and used quite extensively as a vegetable; the seeds are also gathered and eaten. Of wide distribution, but not cultivated.

PUMPKIN. *Cucurbita pepo* DC.

A cucurbitaceous, annual, trailing vine, grown for its large fruits, which are eaten boiled, with meat, made into pies, etc. Probably native of tropical America. Several varieties are cultivated. The plant is almost universally grown, and is one of the most important vegetables in the Archipelago.

Pungápung, P., T., V. See Oroy.
†Pupú-lo, Il. *Codium tenue* Kütz. See Algae.
Quibal, T. See Cowpea.
Quilala, V. See Sugar cane.
Quimpóy, V. See Gábi.
Quinambóy, V. See Turmeric.
Quinandá, T. See Rice.

†**QUIRÓI.** T. *Dioscorea divaricata* Blanco.

An annual, twining vine, with round stem, sparse, short spines, and perennial, long, slender, fleshy tubers, attaining a length of over 2 meters. Gathered and eaten baked or boiled, when it is grayish, and of fair quality. Of wide distribution, but not in cultivation.

Quitícot, V. See Chíle.
Rábano, Sp. See Radish.
Raboc, Il. See Gabi.

RADISH. *Raphanus sativus* L.

An annual, quick-growing herb, believed to be indigenous to southwestern Europe and eastern Asia, widely cultivated for its fleshy roots; gives very satisfactory results at all elevations. The large, long, white, Chinese variety leads in popularity.

Ratipan, Il. See Kaong.
Rautnocara, Ib. See Borona.
Remolacha, Sp. See Beets.
Repollo, Sp. See Cabbage.

RHUBARB. *Rheum rhaponticum* L.

An herbaceous perennial with large leaves, attaining a height of about 1 meter, native of Asia Minor, grown for its succulent leaf stalks, which are boiled, and, with sugar added, eaten as sauce with meat, or used for filling pies, etc. Requires very rich soil and an elevation of not less than 1,000 meters in order to give good results.

RICE. *Oryza sativa* L.

An erect, annual grass, 0.75 to 1.50 meters tall, extensively cultivated for its seeds, which constitute the rice of commerce. Native of tropical Asia. (Pl. I.)

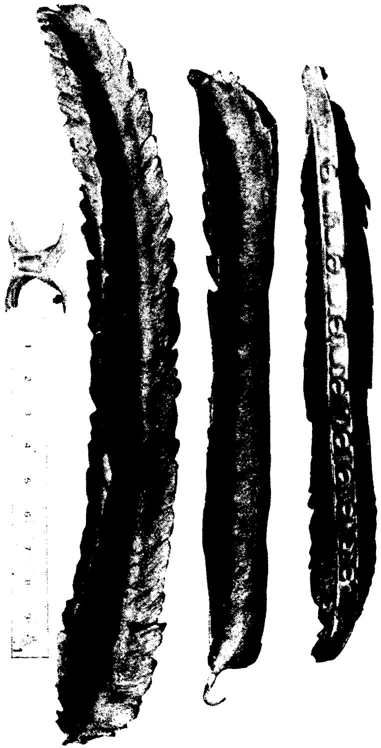
Rice is by far the most important cereal in the Philippines, 13,363,868 hectoliters of palay (rough rice), valued at $24,603,989, being produced in 1915 on an area of 1,130,713 hectares, with an average production of nearly 12 hectoliters (688 kilos) per hectare.

During the same year the six leading rice-producing provinces had the following areas under rice and total yield each in palay (rough or unhulled rice):

	Hectares.	Hectoliters.
Pangasinan	145,627	1,543,544
Nueva Ecija	84,989	1,386,034
Tarlac	60,303	880,852
Bulacan	58,742	764,783
Pampanga	57,585	689,724
Capiz	52,040	902,416

(*a*) A field of beans, *Phaseolus vulgaris;* sugar corn in the background. Lamao Experiment Station.

(*b*) A field of the tongo, *Dioscorea aculeata,* illustrating manner of planting. Lamao Experiment Station.



(*a*) The seguidilla, *Psophocarpus tetragonolobus.*

(*b*) A well proportioned tongo, *Dioscorea aculeata.*

(*c*) Seed capsules and seed of the lotus, *Nelumbium speciosum.*

The Philippine rice varieties are classified into 16 groups as follows:

- Rice
  - Upland
    - Awned
      - Glutinous: White. / Colored.
      - Nonglutinous: White. / Colored.
    - Awnless
      - Glutinous: White. / Colored.
      - Nonglutinous: White. / Colored.
  - Lowland
    - Awned
      - Glutinous: White. / Colored.
      - Nonglutinous: White. / Colored.
    - Awnless
      - Glutinous: White. / Colored.
      - Nonglutinous: White. / Colored.

Rice falls into two large groups, upland and lowland, according to the cultural requirements. Upland rice is grown without submersion and lowland rice is cultivated in rice paddies which are flooded more or less during the growing period of the rice.

The chief difference between awned and awnless rice is that the awned rice succeeds better than awnless rice on very wet lands, as it has a stiffer and longer straw, and does not shatter as badly as awnless rice after ripening.

From the consumers viewpoint, the varieties, whether upland or lowland, awned or awnless, are divided into glutinous and nonglutinous rice, and these two classes are again separated into white and colored rice.

Commercially, the nonglutinous white rice is the most important type in the Philippines, constituting about 75 per cent of all the rice produced.

Colored rice is coarser than white, is used mostly for animal feed, and is usually employed as human food only when white rice is not obtainable.

Glutinous rice is of limited production, and used chiefly in making various sweetmeats, being very soft and pasty when cooked. In the following alphabetical list of the rice varieties in the Philippines all varieties preceeded by (*) yield 2,400 kilos or more per hectare, all other varieties yielding less than 2,400 kilos per hectare. The various forms as explained above are indicated by the following abbreviations: u=upland; l=lowland; a=awned; al=awnless; g=glutinous; ng=nonglutinous; w=white; c=colored.

Agabon (syn. Guyud)	u-al-ng-w
Agoyor I (syn. Kinandang Puti I)	u-al-ng-w
Alaminos	l-a-ng-w
*Alegria	u-al-ng-w
Alfonsino	l-a-ng-w
Alibangnon (syn. Loma)	u-al-ng-w

Alibasa	u-al-ng-w
Amarillo I (syn. Tabucanon II)	u-al-ng-w
*Amarillo II	l-al-ng-w
Amayan	u-al-ng-w
*Ambaba-ay	l- a-ng-w
Amusco	l-al-ng-w
Animas	u-al-ng-w
Arabon	l-al-ng-w
Arcupal	l- a-ng- c
Aribongbong	l- a-ng-w
Aringay	l- a-ng- c
Azucena	l- a-ng-w
Bacao	l-al-ng- c
Bacao-Bajo	l-al-ng-w
*Bacnang	l- a-ng-w
Bacnotan (syn. Grana Sabutan)	l- a-ng-w
*Bacras	u-al-ng-w
*Bad-as	l-al-ng-w
Bagonhon	u-al-ng- c
Balagadan	l-al-ng-w
*Balam (syn. Binarit III, Bulagsac I, and Lubang I)	u-al-ng- c
Balañgen	l- a-ng-w
Balasang (syn. Santo Niño)	l-al-ng-w
Balayad-Purao	l- a-ng-w
*Balayangnon	u-al- g-w
*Balibod (syn. Libod and Nagsanoot)	u-al-ng-w
Baliuag	l- a- g-w
*Baliw	l- a-ng-w
Balodnon	u-al-ng-w
Balolaqui-Pula	l- a-ng-w
Bandera á Bayág	l- a-ng-w
Bangbang Pula	l-al-ng- c
Banglam	u-al-ng-w
Banla I (syn. Malines & Pinirot)	l- a-ng-w
Baquet	l- a- g-w
Baranay (syn. Binagacay I)	l- a-ng-w
Barangcal	l-al-ng-w
Barog (syn. Binacal)	l- a-ng-w
Barotak	l- a- g- c
Barsañga (syn. Sampurin)	l- a-ng-w
Basilanon	u-al-ng- c
Baticang	l- a-ng- c
Batuan	l- a-ng-w
Batulinew Lagkit	l- a- g- c
*Baybay	l-al-ng-w
Bayon	l-al-ng- c
Bengala	l-al-ng-w
*Bersabe	u-al-ng-w
Biday (syn. Viday II)	u-al-ng-w
*Bilibid	u-al-ng-w
Binabay	u-al-ng-w
Binabaye I	u-al-ng-w
*Binabaye II (syn. Inilang-ilang and Inalañgilan)	u-al- g-w
Binaboy	u-al-ng-w
Binacal (see Barog)	l- a-ng-w
Binacayao I (Palauig, Zambales)	u-al-ng-w
Binacayao II (Iba, Zambales)	l-al-ng-w
Binac-hao	l-al-ng- c
Binacloy	l- a-ng-w
*Binacroy (syn. Cusimay-Buric)	l- a-ng-w
Binagacay I (Camarines) (see Baranay)	l- a-ng-w
Binagacay II (Occidental Negros)	l- a-ng-w
Binaghay	u-al-ng-w
Binagontauo	u-al-ng-w
Binalayong	u-al-ng-w
*Binalibod	l-al- g-w
Binambang	l-al-ng-w
Binangcal	u-al- g- c
Binanquero	l-al-ng-w
*Binarire	u-al-ng-w
*Binarit I (syn. Granada and Sinanglaycabiitan)	u-al-ng- c
*Binarit III (see Balam)	u-al-ng- c
Binatad (see Mcan Tago I.)	l-al-ng-w
Binatañgan	u-al- g-w
Binato	l-al-ng-w
Binayabas	l- a- g-w
Binicol I	u-al-ng-w
Biningbing	u-al-ng-w
Binirajo (syn. Capuñgot)	u-al-ng- c
Binisaya	u-al-ng-w
Binitoon	l- a-ng-w
*Binitoon-Oldog	l-al-ng-w
Binmaley	l- a-ng-w
*Binogña (see Catorsa)	u-al-ng- c
Binolinao	l- a-ng-w
Binondoc I	u-al-ng-w

Binucaue	al–ng–w
*Binugatan-Carcar	l–al–ng– c
Binuhañgin I (Batangas)	u–al–ng–w
Binuhañgin III	l–al–ng–w
Binurí	l–al–ng–w
Bircacoc á Bayag	l– a–ng–w
*Bircacoc á Dalusong	l– a–ng–w
Bisal (syn. Castañeda, Sambilac I, Sambilac III, and Sinoyod)	l– a– g–w
*Boacnaga	u–al–ng–w
*Bolinog	l– a–ng– c
Bonguet	u–al–ng–w
*Bonlay	l–al–ng–w
Borace	l– a–ng–w
*Boracnaga	l–al–ng–w
Botanes	l– a–ng–w
*Bugatem	l–al–ng–w
*Bugaten	l–al–ng–w
Bulacnaga (syn. Bulagnaga, Caviteño and Fino)	u–al–ng–w
Bulagnaga (see Bulacnaga)	u–al–ng–w
*Bulagsac I (see Balam)	u–al–ng– c
*Bulagsac II (see Sanglay Putí)	l–al–ng–w
*Bulagsac III	l–al–ng– c
*Bulagsac Blanco	u–al–ng–w
*Bulagsac Nagsaclob	u–al–ng– c
Bulagsac na Inantipolo	u–al–ng–w
Bulandi (syn. Linion)	u–al–ng–w
*Bulao I (Albay)	u–al–ng–w
Bulao III	l–al–ng– c
Bulaquiqui	l–al–ng–w
Bulic	l– a–ng–w
Bul-lilising	l– a– g–w
Bulineg	l– a–ng–w
Bulühan (syn. Kiniristal)	al–ng–w
Buluhan Dumali	u–al–ng–w
Buluhan Silang	u–al–ng–w
Bundoc	al–ng–w
*Burangcal	l–al–ng–w
Burañgen	l– a–ng–w
Burata	u–al–ng–w
Busisi I (syn. Malinanon)	u–al–ng–w
*Busisi II	u–al–ng–w
*Butangan	u–al–ng–w
Caayad	u–al–ng– c
Cabadlong	l–al– g–w
*Cabagbag	u–al– g–w
Cabago I (Iloilo)	l–al–ng–w
Cabago II (Occidental Negros)	u–al–ng–w
Cabanay	u–al–ng–w
Cabang	l–al–ng–w
Cabañgin	u–al–ng–w
Cabanglan	l–al–ng–w
Cabangue	u–al–ng–w
*Cabantong	l–al–ng–w
Caba-ong (see Caboong I)	al–ng–w
*Cabatiñgan	u–al– g–w
Cabayoran	l– a–ng–w
Cabellada	u–al–ng–w
Cabiday	al–ng–w
Cabilao (syn. Quinaorey)	u–al–ng–w
Cabolan	u–al–ng–w
Caboong I (syn. Caba-ong)	al–ng–w
Cabonbon	u–al–ng–w
Caboni (see Porbida)	u–al–ng–w
Cabono	u–al–ng–w
Cabonog	u–al–ng–w
Caboong I (Antique)	u–al–ng–w
*Caboong II	u–al– g–w
Caborgo	u–al–ng–w
Caborong	l–al–ng–w
*Cabucay	u–al–ng–w
Cabugnay	al–ng–w
Cabulao	al–ng–w
Cabunlao (syn. Calocot)	u–al–ng–w
Cabuyo (syn. Somarocsoc)	l–al–ng–w
Cabuyoc I (Misamis) (syn. Calinquit)	u–al–ng– c
Cabuyoc II (Samar)	l–al–ng–w
*Cadacag I	u–al–ng–w
Cadaguit I	u–al–ng– c
Cadaguit II (see Casaquit)	al–ng– c
Cadimaya	u–al–ng–w
Cadocag	l–al–ng–w
Cagaid	u–al–ng–w
Cainti I	u–al–ng–w
*Cainti II	l–al–ng–w
*Cairog	u–al–ng–w
Calaguio (See Ulian)	u–al–ng–w
*Calahoy	u–al–ng–w
Calampoñgan (see Capantao)	u–al–ng–w

Calamyan	u–al–ng–w
Calanay I (syn. Capino II)	u–al–ng–w
Calanay IV (Occidental Negros) (see Gumalit)	u–al– g–w
Calañgay	l– a–ng–w
Calangcang	u–al–ng– c
*Calangyo I	u–al–ng–w
Calanoche	l– a– g–w
Calañag (syn. Calañang)	u–al–ng–w
Calañang (see Calañag)	u–al–ng–w
Calapdos	u–al–ng–w
Calaquinggay	u–al– g–w
Calasanon (syn. Hindaganon)	u–al–ng–w
Calaua	l–al–ng–w
Calaya	u–al– g– c
*Calibo I	u–al–ng–w
*Caligaya III	u–al–ng– c
Caligaya IV	l–al–ng–w
Calinao I	u–al–ng–w
Calinao II (Antique)	l–al–ng– c
Calinquit (see Cabuyoc I)	u–al–ng– c
*Calipay I	l–al–ng–w
*Calipay II (Surigao)	u–al–ng–w
Calirit	l–al–ng–w
Caliso	l–al–ng–w
Calivo I (see Talankao)	u–al–ng–w
*Calivo II (Zambales)	u–al–ng–w
*Calobad	l–al–ng– c
*Calobang	l–al–ng–w
Calocot (see Cabunlao)	u–al–ng–w
Calodo (syn. Manabaco)	l–al– g–w
Calong	u–al–ng–w
Calonod (see Capantao)	u–al–ng–w
Calotac (Occidental Negros)	l–al–ng–w
Calubad I (Occidental Negros)	l–al– g– c
Calubad II (Antique)	l–al–ng– c
Calumpit (syn. Diamante IV and Saigon IV)	l–al–ng–w
Caluñgi	l– a–ng–w
Calu-os	u–al–ng–w
Caluros	u–al–ng–w
Calutac	u–al–ng–w
Camarines	al–ng–w
Camiling I	l– a–ng–w
Camiling II (see Inalasan)	l– a– g–w
*Canato	u–al–ng–w
Cancang	u–al–ng–w
Candelaria	l– a–ng–w
Cañgolia	al–ng–w
Cañgon	u–al–ng–w
*Caoñgedy	u–al–ng–w
Capache	u–al– g– c
Capagsic	u–al–ng–w
Capanod (syn. Capaod)	u–al– g– c
Capantao (syn. Calonod and Calampoñgan)	u–al–ng–w
Capaod (see Capanod)	u–al– g– c
Capao-Pula (syn. Tuhao I)	l–al–ng– c
Capaque	l–al–ng– c
Capichola	u–al–ng–w
*Capigsic	u–al–ng–w
Capigued	l– a–ng–w
Capingcao	l–al–ng–w
Capino I (syn. Inocot)	u–al–ng–w
Capino II (see Calanay I)	u–al–ng–w
Caporcas I (syn. Julilan)	u–al–ng–w
*Capotol	u–al–ng–w
Capucao I	u–al–ng– c
Capucao II	u–al–ng–w
Capuñgot (see Binirajo)	u–al–ng– c
Capuñgot	u–al–ng–w
Caputol III (Sorsogon)	l–al– g–w
Caputol IV	l–al–ng– c
Caputol V	l–al–ng–w
Carangcang	u–al–ng–w
*Carangcang ñga Itom	u–al–ng–w
Caraui II	u–al–ng–w
*Carauis	u–al–ng–w
*Caraya I	u–al–ng–w
Caraya II (Antique)	u–al–ng– c
Caricot	al–ng–w
Carimay	u–al–ng– c
*Carnate	u–al– g– c
Carolina	u–al–ng–w
Caromayan	u–al–ng–w
Caroray	u–al–ng–w
Caruña	u–al–ng–w
Casacao I	u–al–ng–w
Casaquit (syn. Cadaguit II)	l–al–ng– c
Casibe	l– a–ng–w
Casibong (syn. Inorani)	l–al– g–w
Caso-ay	u–al–ng– c
Casobong (syn. Casugon)	l–al–ng–w

Castañeda (see Bisal)	l– a– g–w
Casugon (see Casobong)	l–al–ng–w
Catalong	u–al–ng–w
*Catamlagñan	u–al–ng– c
Catan-ag	u–al–ng–w
Catibos	u–al–ng–w
Catinao	l–al–ng–w
Catlon-Bulan	u– a–ng–w
Caton-og (see Culaui)	u–al–ng–w
Catonog	l–al–ng–w
Catorce (see Guiron)	u–al–ng–w
*Catorsa (syn. Binogña)	u–al–ng– c
Catsori	u–al–ng–w
Catunda	u–al–ng–w
*Catutoc	u–al–ng–w
*Cauaas	u–al–ng–w
Cauili	u–al–ng–w
Caviteña-Iloco	l– a–ng–w
Caviteñang Nagmaliw	l–al–ng–w
Caviteña Tagalog	l–al–ng– c
Caviteño (see Bulacnaga)	u–al–ng–w
Cayading	l– a–ng– c
Cayahan (syn. Palaynon)	u–al–ng–w
Cayangcang	al–ng–w
Cayaya (syn. Saca)	u–al–ng–w
*Celedoña I	u–al–ng–w
*Clarito	u–al– g–w
Cocong Uwak (syn. Polotan sa Mayobo)	l– a– g– c
*Coliit	u–al–ng–w
Compas	u–al–ng–w
*Corales	u–al– g– c
Coran	al–ng–w
Coratsay	l–al–ng– c
Cordillero	l– a–ng–w
Cotsiam (syn. Mañgailala)	u–al–ng– c
Culaui (syn. Caton-og and Tigbauanon)	u–al–ng–w
*Cusimay-Buric (see Binacroy)	l– a–ng–w
Cusimay-Nalabaga	l– a–ng–w
Cutsiam (see Quinupang)	u–al–ng– c
Dalaog	l–al–ng–w
Daldal	l– a–ng– c
Dali	l–al–ng–w
Daliket (syn. Sanglay)	u–al–ng–w
*Daliquet (Camarines)	u–al–ng–w
Dal-lidal-lot	l– a– g–w
Dalua (see Tarbayanon II)	l–al–ng–w
Dalusan	l– a–ng–w
Dalusong (syn. Mañgaldan)	l– a–ng–w
Dame	u–al–ng–w
Daohog	l–al–ng–w
*Dapog	u–al–ng–w
*Dasol	l–al–ng–w
Dauling	l–al–ng– c
Dayami	u–al–ng–w
Dayhaganon	u–al–ng–w
Dayomi Tapol	u–al–ng– c
*Dayoyo II	u–al– g–w
Diamante I (see Puerto)	u–al–ng–w
Diamante III (Antique)	u–al–ng–w
Diamante IV (see Calumpit)	l–al–ng–w
*Diamante V	l–al–ng–w
Dinagat I (Batangas)	u–al–ng–w
Dinagat II (Laguna)	l–al–ng–w
*Dinalaga I (Tayabas)	u–al– g–w
Dinalaga II (Tarlac) (see Inomalit)	l– a–ng–w
*Dinalaga III (Zambales) (see Macatlo)	u–al–ng– c
*Dinalaga IV (Rizal)	u–al–ng–w
*Dinamiana	u–al–ng–w
Dinicola	l– a–ng–w
Dinominga I	l–al–ng–w
Dinominga II (Nueva Ecija)	l–al–ng–w
Dinorado	u–al–ng–w
Diquet a Olandez (see Inalasan)	l– a– g–w
Dollar	l– a–ng–w
Dumaling-Caawa (syn. Magasawang-Palay)	u–al–ng–w
Dumpas (syn. Lanconon)	u–al–ng–w
Dumudao	u–al–ng–w
Eaca	u–al–ng–w
Eacapino	l– a–ng– c
Eninian	u–al–ng–w
Eput-Ebun	l–al–ng–w
Espiritu	l– a–ng–w
Fino (see Bulacnaga)	u–al–ng–w
Fiscal	l– a–ng–w
Gamay	u–al–ng–w
Ganado á Lacáy	l– a–ng–w
Garaygay	l– a–ng–w
Gayang	l– a– g–w

*Gayangang Blanco .... u–al–ng– c
Gayangang Negro .... u–al–ng– c
Ginalo-an (see Hinlu-ay Pilit) .... u–al– g–w
Gono .... u–al–ng–w
Goyod I .... l–al–ng–w
Goyod II (Pangasinan) l– a–ng–w
Goyodan (see Manteca a Nalabaga) .... l– a–ng–w
Gracia .... l– a–ng–w
Grana I (Zambales)...... l–al–ng– c
*Grana II (Pangasinan) .... l– a–ng–w
Grana á Purao........ l–al–ng–w
*Granada (see Binarit I) .... u–al–ng– c
Grana Sabutan (see Bacnotan) .... l– a–ng–w
Granate .... u–al– g–w
Granatis .... l–al–ng–w
Guinanado .... l– a–ng–w
Guinanahan .... al–ng–w
*Guinangang .... l–al–ng–w
Guinarab .... u–al–ng–w
Guinaroan .... l–al– g– c
*Guinatus .... l–al–ng–w
Guinolong (syn. Gumaid II) .... l–al–ng–w
Guinoyoran .... l– a– g–w
Guinulong (see Pregonse) .... u–al–ng–w
Gui-os I .... u–al–ng–w
Guiron (syn. Catorce).. u–al–ng–w
*Guluya .... u–al–ng–w
*Gumaid I .... u–al– g–w
Gumaid II (see Guinolong) .... l–al–ng–w
Gumalit (syn. Calanay IV) .... u–al– g–w
Guyod .... u–al–ng–w
Guyud (see Agabon)...... u–al–ng–w
*Halbayanon .... l–al–ng–w
Hermosa (see Inalasan) l– a– g–w
Hindaganon (see Calasanon) .... u–al–ng–w
Hinirang .... l–al–ng–w
Hinlu-ay Pilit (syn. Ginaloan) .... u–al– g–w
Hispoc .... l–al– g–w
*Ignacio .... u–al– g–w
Igolot .... u– a–ng–w
Igorot .... l– a–ng–w
Ilajas .... u–al–ng–w
Ilan͠gitnon .... l–al–ng–w
Ilog .... l–al–ng–w
Imung Daya-ot .... l– a– g–w
Imus .... l–al–ng– c
*Inachupal .... l–al–ng–w
Inacloy .... l– a–ng–w
Inaculao .... l– a–ng–w
Inagoyan .... u–al–ng–w
*Inaguas Grandes (syn. Inaguas Pequeñas).... l–al–ng–w
*Inaguas Pequeñas (see Inaguas Grandes)...... l–al–ng–w
*Inaguio .... l–al–ng–w
Inagul .... u–al–ng–w
Inalanao .... u–al–ng–w
*Inalan͠gilan (see Binabaye II)........ u–al– g–w
Inalasan (syn. Camiling, Hermosa, Salasa, Polalante and Diquet a Olandez) .... l– a– g–w
Inalsa .... l–al–ng– c
Inanadios .... l–al–ng–w
*Inangel .... u–al– g– c
Inanggue .... u–al–ng–w
Inanis .... u–al–ng–w
*Inanod .... u–al–ng–w
Inantipolo I (see Pileng Baybay) .... u–al–ng–w
*Inantipolo II .... u–al–ng–w
*Inaransing (syn. Marigaya) .... u–al– g– c
Inarapel .... l– a–ng–w
*Inasimang .... l–al–ng–w
Inaslom .... u–al–ng–w
Inespaña .... u–al– g– c
Inilang-ilang (see Binabaye II)........ u–al– g–w
Inipon I .... l– a–ng–w
Initiwtiw .... al–ng–w
Inocot (see Capino I).... u–al–ng–w
Inolayan .... u–al–ng–w
Inomalit (syn. Dinalaga II) .... l– a–ng–w
Inorani (see Casibong) l–al– g–w
Inoropel (see Milagrosa) .... u–al– g– c
Inouay (see Tahodilahas) .... u–al–ng–w
Inudiong I (syn. Pinascuala I) .... l–al–ng–w

Inuwak	l– a– g–w
Iput-Ibon	l–al–ng– c
Iray (see Manteca á Nalabaga)	l– a–ng–w
Ituin-Oldog	l–al–ng–w
Itui Uroc	l–al–ng– c
Jazmin	l– a–ng–w
Jinaloan	l–al– g–w
*Jinipon	l–al–ng–w
Jinos	u–al–ng–w
Joani (syn. Postoguer)	l–al–ng–w
Joquianan (see Tuguianan)	l–al–ng–w
*Judlot	u–al–ng–w
Julilan (see Caporcas I)	u–al–ng–w
*Kachure	u–al–ng–w
Kalibod	u–al–ng–w
Kalo	u–al–ng–w
Kalutac	l–al–ng–w
*Kinabalhog	u–al– g–w
Kinamaguian	u–al–ng–w
Kinanay	u–al–ng–w
Kinandang-Puti I (see Agoyor I)	u–al–ng–w
*Kinandang-Puti II	u–al–ng–w
*Kinarabao	l–al–ng–w
*Kinarayom	u–al–ng–w
*Kinastaño I	u– a–ng–w
*Kinastilla (Tayabas) (syn. Pulupot II and Quinastila II)	u–al– g–w
*Kinawayan I (Tayabas)	u–al–ng–w
*Kinawayan II (Laguna)	l–al–ng–w
Kiniristal (see Buluhan)	al–ng–w
*Kinogon	u–al– g–w
Kumaguingquing	u–al–ng–w
*Kuto	u–al–ng–w
Laca	u–al–ng–w
Lacatan-Tago (syn. Santa Maria)	l– a– g–w
Lacay á Diquet	l– a– g–w
*Lagmac	u–al–ng–w
*Laguingan	l– a–ng–w
Laguiñgay II (syn. Malaguiñgay)	u–al– g–w
*Lamponaya	u–al–ng–w
*Lana	l–al–ng–w
Lanconon (see Dumpas)	u–al–ng–w
Lañgahid (syn. Sinambauan II)	u–al–ng–w
*Las Piñas	u–al– g–w
*Libod (see Balibod)	u–al–ng–w
*Linacray	l–al–ng–w
Linion (see Bulandi)	u–al–ng–w
Lirio	l–al–ng–w
Loca II (see Pulang-Balat)	u–al–ng–w
Loma (see Alibangnon)	u–al–ng–w
*Lubang I (see Balam)	u–al–ng– c
*Lubang II (see Pauni)	l–al–ng–w
Lubang IV	l–al–ng– c
Lubang-Luay	l–al–ng–w
Iubang-Pula	l–al–ng– c
Lubang-Puti	l–al–ng–w
Maauey (see Portoc)	l–al– g–w
Mabolo I	l– a–ng– c
Macaanay	l– a–ng–w
Macabebe	l–al–ng–w
Macan (see Macan Santa Rita)	l–al–ng–w
Macan Aga	l–al–ng–w
Macan Bocaue	l– a–ng–w
*Macanene	l– a–ng– c
*Macan Piña	l–al–ng–w
Macan Santa Rita (syn. Macan, and Macan Silañgan)	l–al–ng–w
*Macan Señora	l–al–ng–w
Macan Silañgan (see Macan Santa Rita)	l–al–ng–w
Macan Tago I. (syn. Binatad)	l–al–ng–w
Macarañag I	l– a–ng–w
Macariro	l– a– g–w
Macatibos	u–al–ng–w
Macatlo (syn. Dinalaga III)	u–al–ng– c
Madayao (syn. Tudlo-et Madayao)	u–al–ng–w
*Madolao	u–al–ng–w
Magasawang-Palay (see Dumaling Caawa)	u–al–ng–w
Magaya Tapol	u–al–ng– c
Magbaliw	l–al–ng– c
Magcarotol	u–al– g– c
Magcumpol	l–al–ng–w
*Magcutay	u–al–ng–w
*Magpile	u–al–ng–w
Magponit	l– a–ng–w
Magpunit	l–al– g– c

Magsalit	l-al-ng-w
Magsampong I	u- a-ng-w
*Magsanaya (syn. Tabucanon I)	u-al-ng-w
Magsuhay (syn. San Pablo I)	u-al-ng-w
*Maguilom	l-al-ng-w
*Maguin-os	u-al-ng-w
Magunidanao	u-al-ng-w
Malabago	u-al-ng-w
Malaca I (Pangasinan)	l- a- g-w
Malaca II (Tarlac)	l- a-ng-w
*Malaca III (Pampanga)	l-al-ng-w
Malaga	l- a-ng-w
Malagaya	u-al-ng-w
Malagkit	l-al- g- c
Malagquit Pulot	u-al- g- c
Malaguiñgay (see Laguiñgay II)	u-al- g-w
Malasiao	l- a-ng-w
Malatquit Negro	u-al- g- c
Malay	l-al-ng-w
*Malido	u-al-ng-w
Malinanon (see Busisi I)	u-al-ng-w
*Malines (see Banla I)	l- a-ng-w
Maliro	u-al-ng-w
Maliw	l-al-ng-w
Malubang	l- a-ng-w
Mambog	l- a-ng-w
Manabaco (see Calodo)	l-al- g-w
Manabun-ac	l-al-ng-w
*Managarao II	l-al-ng- c
Manay	l-al-ng-w
*Mancasar	l-al-ng-w
Mandigorin	l- a-ng-w
Mandogosoc	u-al-ng-w
Mañgaldan (see Dalusong)	l- a-ng-w
Mangasá	l-al-ng-w
Mañgilala (see Cotsiam)	u-al-ng- c
Mañgili (see Quiquirin)	l-al-ng-w
Mañgindanao (Occidental Negros)	l-al- g-w
Mañgunidanao	u-al-ng-w
*Manilan-on (syn. Tallacan)	u-al-ng-w
Maniñgala	u-al- g- c
Manitay	l-al-ng-w
*Manteca á Bayag	l- a-ng-w
Manteca á Nalabaga (syn. Goyodan and Iray)	l- a-ng-w
Manteca á Purao	l- a-ng-w
*Manteca Pilit	u-al-ng-w
*Mantecanon	l-al-ng-w
Manuela II	u-al- g-w
*Manumbalay I	u-al-ng-w
Maragadang	l- a-ng- c
*Maranay	l-al-ng-w
Maribquel	l- a-ng-w
*Marigaya (see Inaransing)	u-al- g- c
Marinay	l-al-ng-w
Maro-anon	u-al-ng-w
Masuliao	l- a-ng-w
Matabia (see Saysayen)	l-al-ng-w
Mata-it-ibit (see Pungdol)	u-al-ng-w
*Mayoro	u-al-ng-w
Milagrosa (syn. Inoropel and Sinibuyas I.)	u-al- g- c
Mimioc	u-al-ng- c
Mimis I	l-al-ng-w
Mimis Morado	l- a-ng- c
Minantica I (Batangas)	u-al- g- c
Minantica II (Tayabas)	u-al- g-w
Minantica III	l-al- g-w
*Minasanting	u-al-ng-w
*Minatanda II	u-al-ng-w
Minaya	l-al-ng-w
Minindoro	l- a-ng-w
Ministiza	l- a-ng-w
*Mitao	u-al-ng-w
*Molan-ay	l-al-ng-w
Mole	u-al-ng-w
Mongcol	u-al-ng-w
Morado III (see Quinastaño)	l-al- g-w
Mulchion	l- a-ng-w
Murson	l- a-ng-w
*Nagcayat	u-al- g-w
*Nagdami	u-al-ng-w
Nagsano-ot (see Balibod)	l-al-ng-w
*Nagsaya	u-al-ng-w
*Nagsayang Mahaba	u-al-ng-w
Nagsayang Pula	u-al-ng-w
Nalizon	u-al-ng-w
Nalmoan (see Payacan)	l- a- g-w
Ñgirñgir	l- a-ng-w
Niñur	l-al-ng-w

*Ohoy I .... l–al–ng–w
Oinote (see Ventura) .... u–al–ng–w
Onac .... u–al– g–w
Ontalamis I .... u–al–ng–w
Orpel (syn. Tabâ) .... u–al– g– c
Oscuro .... u–al– g–w
Palagang á Bayag .... l– a–ng–w
*Palaguingguing .... u–al–ng–w
Palaynon (see Cayahan) .... u–al–ng–w
Pallacate .... l– a–ng–w
Paraya .... l–al–ng–w
*Pauni (syn. Lubang II) l–al–ng–w
Payacan (syn. Nalmoan) .... l– a– g–w
Payong .... l–al–ng–w
Payyapay .... l– a–ng– c
Penasil .... u–al–ng–w
Pias .... l– a–ng–w
Pias á Bayag .... l– a–ng–w
Pilapil I .... l–al– g–w
Pilapil II (see Tahodilahas) .... u–al–ng–w
Pileng Baybay (syn. Inantipolo I.) .... u–al–ng–w
*Pilit Cayom .... u–al– g–w
*Pilit Coricol .... u–al– g–w
Pilit Inagiw .... u–al– g–w
*Pilit Kinarabao .... l–al– g–w
Pilit Manteca .... l–al– g– c
*Pilit Siscuat .... u–al– g–w
Pilit Talo .... l–al– g–w
*Pinalengke .... u–al–ng–w
*Pinan͠ga .... u–al– g– c
Pinangdan .... u–al–ng–w
Pinanilan .... l–al–ng–w
Pinascuala I (see Inudiong I) .... l–al–ng–w
Pinias .... l– a–ng–w
Pinili I (Pangasinan) .. l– a–ng–w
Pinili II .... l–al–ng– c
*Piniling-Baybay .... u–al–ng–w
Piniling Bertu I .... l– a–ng–w
Piniling Daniel .... l–al–ng–w
Pinino .... l–al– g–w
*Pinirot (see Banla I) .... l– a–ng–w
Pinorsigue .... u–al–ng–w
*Pinotiocan .... u–al–ng– c
Pinukiutan .... l–al– g–w
Pinulot .... u–al–ng–w
*Pinutiucan .... u–al– g– c
Pipino .... l–al– g–w
*Piracat .... u–al– g–w
Pirurutong I (Tayabas) .... u–al–ng– c
*Pirurutong II .... u–al– g– c
Polalante (see Inalasan) .... l– a– g–w
Polotan sa Mayobo (see Cocong Uwak) .... l–al– g– c
Porbida (syn. Caboni) .. u–al–ng–w
Portoc (syn. Maauey and Quinalabao II) .... l–al– g–w
Portoc Colorado .... l–al–ng– c
Postoguer (see Joani) .... l–al–ng–w
Potan Tandu .... u–al– g– c
Pototan .... l– a–ng– c
Pregonse (syn. Guinulong) .... u–al–ng–w
Principe .... l– a–ng–w
Puerto (syn. Diamante I) .... u–al–ng–w
Pulang-Balat (syn. Loca II) .... u–al–ng–w
*Pulupot I (Tayabas) .... u–al–ng–w
Pulupot II (Batangas) (see Quinastila II) .... u–al– g–w
*Pulutan I (Albay) .... u–al–ng– c
*Pulutan II (see Tapuy) u–al– g– c
Pulutan III (Camarines) .... l– a– g– c
*Pungdol (syn. Mata-itibid .... u–al–ng–w
Putyucanon .... l–al–ng–w
Quinabayo I .... u– a–ng–w
Quinabebe .... u–al–ng–w
Quinaboy .... u–al–ng–w
Quinad-uas .... u–al–ng–w
Quinaguingquing .... u–al–ng–w
*Quinalabao I .... l–al– g–w
Quinalabao II (see Portoc) .... l–al– g–w
Quinalibo .... u–al–ng–w
Quinallos .... l– a–ng–w
Quinal-uay .... l–al–ng–w
Quinamalig .... u–al–ng–w
Quinamantigue .... u–al–ng–w
Quinamias .... l– a–ng–w
*Quinanay .... l–al–ng–w
Quinantores I .... u–al–ng–w
Quinantores II .... l– a–ng–w
Quinaoras .... l–al–ng–w
Quinaorey (see Cabilao) u–al–ng–w
*Quinaoris I .... u–al–ng–w
Quinarne (syn. Tinta II) .... al– g–w

Quinastaño (Zambales) (see Morado III)	l-al-ng-w
Quinastido	l- a-ng-w
Quinastila I	u-al-ng-w
*Quinastila II (see Kinastilla)	u-al- g-w
*Quinastilla	u-al-ng-w
*Quinastillo	u-al-ng-w
Quinatia	l-al-ng-w
*Quinatoday	l- a-ng-w
*Quinimon	u-al-ng-w
Quinulagó	u-al-ng-w
Quinulantro	u-al-ng-w
Quinulapó	u-al-ng- c
*Quinupang (syn. Cutsiam)	u-al-ng- c
Quiquirin (syn. Mañgili)	u-al-ng-w
Quiriquiri	l-al-ng-w
Quiyadonce	u-al-ng-w
Reppeng	u- a-ng-w
Romero I (Occidental Negros)	u-al-ng-w
Romero II (Nueva Vizcaya)	l-al-ng-w
*Sabá	l- a-ng-w
Saca (see Cayaya)	u-al-ng-w
*Sacsek	u-al-ng-w
Sagod	l- a-ng-w
Saguboy	u-al-ng-w
Saigon II	l-al-ng-w
Saigon III (Zambales)	l-al-ng- c
Saigon IV (Antique) (see Calumpit)	l-al-ng-w
Salacangcang	u-al-ng-w
Salasa (see Inalasan)	l- a- g-w
Sal-laguid	l- a-ng-w
*Saloot	u-al-ng-w
Samberga	l- a- g-w
Sambilac I (see Bisal)	l- a- g-w
Sambulauan	al- g-w
Sampurin (see Barsañga)	l- a-ng-w
Sañglay (see Daliket)	u-al-ng-w
*Sanglay-Puti (syn. Bulagsac II)	u-al-ng-w
Sanguionan	al-ng- c
*San José I	u-al-ng-w
San José II (see Tinta de Castilla)	u-al- g- c
San José III (Tarlac)	l- a-ng-w
San Juan I (Capiz)	u-al-ng-w
San Juan II	l -al-ng- c
San Juan III (Pangasinan)	l- a-ng-w
San Manuel	l- a-ng-w
San Pablo I (see Magsuhay)	u-al-ng-w
San Pablo II (see Tabacanon)	u-al-ng-w
*San Pablo III	l-al-ng-w
San Pedro	l-al-ng-w
Santa Maria (see Lacatan Tago)	l- a- g-w
Santa Tomasa	l- a-ng-w
*Santo Niño I (Albay)	u-al-ng- c
Santo Niño II (Zambales) (see Balasang)	l-al-ng-w
*San Vicente	l-al-ng-w
Sararola	u-al-ng-w
Sasanglay	l- a-ng-w
Saysayen (syn. Matabia and Sinaba II)	l-al-ng-w
*Señora I (Antique)	u-al-ng-w
*Señora II (Laguna)	l-al-ng-w
*Siany	u-al-ng-w
*Sinaba I	u-al-ng-w
Sinaba II (see Saysayen)	l-al-ng-w
Sinacoban	u-al-ng-w
*Sinaguing I	u-al-ng-w
Sinalapsap	l- a-ng-w
Sinambauan II (see Lañgahid)	u-al-ng-w
Sinampirit	l- a-ng-w
*Sinanglay-Cabiitan (see Binarit I)	u-al-ng- c
Sinangoyor	l- a- g-w
Sinibugnan	l- a-ng-w
Sinibuyas I (see Milagrosa)	u-al- g- c
*Sinibuyas II	l-al-ng-w
Sinoyod (see Bisal)	l- a- g-w
*Sipot	l-al-ng-w
Soladong I (Antique)	l-al-ng-w
Soladong II	l-al- g-w
Solar	l-al-ng-w
Solarum	l-al- g-w
*Solig II	u-al-ng-w
Somarocsoc (see Cabuyo)	l-al-ng-w
Sota	l-al-ng-w
Subaan (syn. Subaan ñga Poctol)	u-al-ng-w

Subaan ñga Bahol	u–al–ng–c
Subaan ñga Poctol (see Subaan)	u–al–ng–w
*Sulig	u–al–ng–c
Tabá (see Orpel)	l–al–g–c
Tabacanon (syn. San Pablo II)	u–al–ng–w
Tabao	u–al–ng–w
*Tabucanon I (see Magsanaya)	u–al–ng–w
Tabucanon II (see Amarillo I)	u–al–ng–w
*Taguianan	l–al–ng–w
Tahodilahas (syn. Inouay and Pilapil II)	u–al–ng–w
*Takilid	l–al–ng–w
Talankao (syn. Calivo I)	u–al–ng–w
Talaya	u–al–ng–c
Tallacan (see Manilanon)	u–al–ng–w
*Talonanon	u–al–ng–w
Tapol III (Oriental Negros)	u–al–ng–c
*Tapul I (Iloilo)	u–al–g–c
*Tapuy (syn. Pulutan II)	u–al–g–c
Tarbayanon II (syn. Dalua)	l–al–ng–w
Tarlac	l–a–g–w
Tayabas	al–ng–w
Tayading	l–a–g–w
*Tayading-Pula	l–al–ng–c
*Tayaring	l–al–ng–c
Tenido	l–a–ng–w
Tigbauanon (see Culaui)	u–al–ng–w
*Tinabas	l–al–ng–w
Tinabuas	u–al–ng–w
Tinabuyog	u–al–ng–c
*Tinalahib	u–al–ng–w
Tinambo	u–al–ng–w
*Tinampucoy	u–al–g–w
Tinanod	u–al–g–w
*Tininoy	u–al–g–c
Tinolamis (see Tulamis	u–al–ng–w
Tinoma	l–al–ng–c
*Tinoma Blanco	u–al–ng–c
*Tinoma Negro	u–al–g–c
Tinomanan	al–ng–w
Tinta I	u–al–g–c
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Tinta III	l–al–g–w
Tinta de Castilla (syn. San José II)	u–al–g–c
*Tinumbaga	u–al–g–w
Tirana	l–a–ng–w
Tiritir	l–a–ng–w
Tomagastos	u–al–ng–w
Tomancon	l–al–ng–w
Tudlo-et Madayao (see Madayao)	u–al–ng–w
Tuguianan (syn. Joquianan)	l–al–ng–w
Tuhao I (Antique) (see Capao-Pula)	l–al–ng–c
Tuhao II (Occidental Negros)	u–al–ng–w
Tulamis (syn. Tinolamis)	u–al–ng–w
Tumanan	l–al–ng–w
Tumatuma	l–al–ng–w
Tumay Tangjon	l–al–ng–w
*Tungcadol	l–al–ng–w
Ulian (syn. Calaguio)	u–al–ng–w
*Vagonhon	u–al–ng–w
Ventura (syn. Oinote)	u–al–ng–w
*Viday I	u–al–ng–w
Viday II (see Biday)	u–al–ng–w
Virgen	l–al–ng–w
X–A	u–al–ng–w
X–B	l–al–g–w
X–C	u–al–ng–w
Yaganon	u–al–ng–w
Zaragoza	l–a–ng–w

Rimorimó, B. See Chile.
Riscapien, Ib. See Marutong.
†**Rupruppúue**, Il., *Eucheuma spinosum* Ag. See Algae.

RUTABAGA. *Brassica campestris* L.

A biennial herb, native of northern Europe, cultivated as an annual for its large, fleshy roots, which are boiled and eaten with meat, in soup, etc. Of local and limited cultivation. For

good results it should not be planted below an altitude of 1,200 meters.

Sabildocon, T. See Marutong.
Sacsác, V. See Sago palm.
Sága, Z. See Nipa.
Sagó, Ib. See Sorghum.

†**SAGO PALM**. *Metroxylon sagu* Rottb.

A medium to rather large palm, attaining a height of 8 to 15 meters, with creeping, suckering stems, from which the trees grow. There are two forms, one with smooth and one with spiny leaf stalks, considered separate species by some botanists. Thrives in a damp climate with abundant rainfall throughout the year, in rich, moist, and even swampy soil, but is intolerant of salt water. Confined to Mindanao and moist sections of the Visayas. The sago is extracted from the trunk by maceration and washing just before the tree comes into flower. Not cultivated; utilized for sago only during times of scarcity of other food (Plate II, *b*.)

Salagsálag, T. See Pacupis.
Salimpócot, T. See Pacupis.

***SALSIFY**. *Tragopogon porrifolius* L.

A biennial herb, native of south Europe, cultivated as an annual for its fleshy, succulent roots, which are eaten parboiled and fried in butter, or prepared in various other ways. Gives excellent results at an elevation of 1,200 meters, but does not succeed well at low elevations. Rarely cultivated.

Sampalia, V. See Apalia.

†**SAPANG**, V. *Dioscorea pentaphylla* L.

An annual, herbaceous, twining vine, 5 to 7 lobate leaves, and rather large, starchy, fleshy, more or less digitate tubers that may be eaten like potatoes. There are two very distinct forms. Should be grown on poles or a trellis for support. Not poisonous. Of general distribution, but not extensively cultivated.

Sasá, B., T., V. See Nipa.
Saua, M. See Lotus.
Saycua, V. See Patóla.

SCARLET RUNNER. *Phaseolus multiflorus* Willd.

A perennial twining vine, grown trained over an arbor or on bamboo poles, cultivated as an annual. The pods are eaten like those of the bean. Succeeds at all elevations but is rarely cultivated.

Seaweed. See Algae.

SEGUIDILLA. *Psophocarpus tetragonolobus* DC.

A perennial, twining vine, grown as an annual, usually on bamboo poles for support; native of India and Malaya. The tender pods are eaten as string beans, to which they are quite equal in quality. There are two distinct varieties in the Philippines. Of wide distribution and fairly commonly cultivated. In some foreign countries varieties with large, fleshy, edible roots are cultivated (Pl. V, *a*.)

SESAME. *Sesamum orientale* L.

An erect, annual herb 50 to 80 centimeters tall, cultivated for its oil-bearing seeds, probably a native of tropical Asia. There are at least two very distinct varieties in the Archipelago. Of wide distribution and grown to some extent, but of no commercial importance. Succeeds well at low and medium elevations.

SHALLOT. *Allium ascalonicum* L.

A dwarf, perennial herb, grown as an annual for its aromatic, fleshy bulbs, which are produced in large clusters; eaten like onions. Known by the writer only from the medium elevations in the Mountain Province, but possibly cultivated elsewhere. Easily grown, and therefore deserving of more attention. Adapted to medium and probably high elevations, and requires rich, friable soil. Probably a native of Asia Minor.

Sibachi, T. See Batao.
Sibúyas, B., P., T., V. See Onion.
Sicay, V. See Úpo.
Sílac, Il. See Buri.
Silad, V. See Buri.
Silag, Il. See Cowpea.
Sileng-bilog. See Pepper.
Síli, B., Ib., Il., T., V. See Chíle.
Síling labuyó, T. See Chíle.
Siluyras, P., T. See Onion.
Simpalia, V. See Apalia.
Sinambáng, V. See Bolinao.

SINCAMA. *Pachyrhizus erosus* Urb.

A climbing herb, indigenous to tropical America, quite extensively cultivated for its fleshy, turniplike root, usually eaten raw, but may also be eaten boiled, parboiled, fried, or grated, mixed with eggs, sugar, milk, and flour, and fried, or made into pudding. The mature roots contain up to 10 per cent starch.

Sincamas, B., Il., T. See Sincama.

SITAO. *Vigna sinensis* Endl.

An herbaceous annual, twining herb, probably native of China, grown on a trellis, with long, slender, reddish to greenish pods, the seeds of which are eaten like lima beans. Of fairly wide distribution and cultivation.

SORGHUM. *Andropogon sorghum* Brot.

A coarse, annual grass 2 to 3 meters high, cultivated as a cereal in many tropical countries, native of India. Of wide distribution but grown to a very limited extent; is of but little importance in the Philippines. Several varieties have been introduced, most of which have made satisfactory growth.

SOYA. *Glycine soja* Benth.

An erect, annual herb 35 or more centimeters tall, the seeds of which are made into flour or otherwise prepared in various ways for the table in India, China, and Japan, and from which a valuable culinary oil is obtained. Of limited distribution and rarely cultivated. Said to have been introduced during the Spanish régime.

***SPINACH,** New Zealand. *Tetragonia expansa* Thunb.

An annual herb, native of Australia, grown to a limited extent for its succulent leaves which are eaten like spinach. Should be grown at and above an elevation of 600 meters for the best results.

SQUASH. *Cucurbita maxima* Duch.

An herbaceous, trailing annual, extensively cultivated for its large fruits, which are eaten as a vegetable with meat. Probably of American origin. One of the most important vegetables in the Philippines; several local varieties are grown.

Subu, V. See Sugar cane.

SUGAR CANE. *Saccharum officinarum* L.

A coarse, perennial grass, attaining a height of 2 to 4 meters, the source of cane sugar. Probably indigenous to tropical Asia. (Plate I.)

Sugar is the third most important crop in the Philippines with an area, in 1915, of 173,092 hectares planted to cane, the crop value of which was $16,606,243, the crude sugar alone being valued at $15,398,260. In the same year the five leading sugar-cane producing provinces with areas in cultivation and value of the products were as follows: Occidental Negros, 53,537 hectares, $7,078,971; Pampanga, 31,292 hectares, $2,515,569; Batangas, 14,071 hectares, $2,391,221; Iloilo, 13,500 hectares, $1,386,495; Tarlac, 6,399 hectares, $532,893.

The better-known Philippine varieties of sugar cane are Inalmon, Cebu Purple, Leyte Striped, Luzon White, and Negros Purple. Of these the Negros Purple is the best all-around "native" cane, with a good yield of cane and a high sugar content (80 metric tons per hectare and a sugar content of 14 per cent), and the most extensively cultivated.

The following varieties of cane have been introduced within the last five years:

Badila.
Black Cheribon.
Cheribon.
Demerara, No. 95.
Demerara, No. 1135.
Hawaii, No. 16.
Hawaii, No. 20.
Hawaii, No. 27.
Hawaii, No. 69.
Hawaii, No. 227.
Hawaii, No. 309.
Imperial Striped Cheribon.
Java, No. 213.
Java, No. 247.
Lahaina.
Louisiana Purple.
Louisiana Striped.
Malabar.
Malagache.
Mauritius, No. 1900.
New Guinea, No. 24.
New Guinea, No. 24–A.
New Guinea, No. 24–B.
New Guinea, No. 40.
Otomato.
Queensland, No. 5.
Queensland, No. 426.
Rose Bamboo.
"Uba."
Yellow Caledonia.

Of these varieties Hawaii No. 20, and Louisiana Striped are the most extensively cultivated in the Archipelago. In the Philippines the yield per hectare in cane and the sugar content of these varieties is about 100 metric tons and 13 per cent.

†**Susueldot-baybay**, Il., *Gracilaria crassa* Harv. See Algae.
Tabias, V. See Cadios.
Tabuloc, T. See Patola.
Tabungao, Il. See Úpo.
Táctac, Il. See Buri.
Tafal, Ib. See Gábi.

*****TALINUM.** *Talinum verticillatum.* (?)

An erect, branching herb, about 1 meter high, with oblong, fleshy, succulent, tender leaves which serve as an excellent vegetable with meat, boiled, like spinach. Recently introduced from Java. May be grown at all seasons, and succeeds well at low and medium elevations.

Tálong, B., T., V. See Eggplant.
Taluquitoc, Mt. See Onion.
Tamis, V. See Tongo.
Tancóng, V. See Cancong.
Tañgi, T. See Rice.
Taróng, Il. See Eggplant.
Táta, Ib. See Nipa.
Taynauac, T. See Bolinao.

Tayóbong, V. See Yabia.
Tegbé, T. See Adlay.
Tibiáyan, V. See Condol.
Tibiayong, V. See Condol.
Ticamás, V. See Sincama.
Tigbi, T. See Adlay.
Tigbicau, B. See Adlay.
Tigsí, V. See Camote.
Tiviay, M. See Borona.
Toad Stools. See Cabuti.
Tócod-láñgit, T., V. See Oroy.

TOMATO. *Lycopersicum esculentum* Mill.

A spreading annual herb, native to tropical America, 0.50 to 1 meter tall, with roundish to flattened, smooth, reddish, acid fruits, 5 or more centimeters in diameter, prepared and eaten in various ways raw and cooked. Many of the small-fruited "preserve" tomatoes are very satisfactory, even at low altitudes. One of the most important vegetables in the Philippines. There is a naturalized form of this species with small, round fruits about 1.5 centimeters across.

Tomáte, Sp. See Tomato.

†**TONGO**, T. *Dioscorea aculeata* L.

A perennial herb with a twining spiny vine and underground tubers, cultivated as an annual, and grown on poles, a trellis or an arbor for support. There are several well-recognized varieties distinguished by the prevalence and size of subterranean spines, and by the size, form, and quality of the tubers, some being large, others small, smooth or more or less covered with hairy roots, dry and mealy to soggy, sweet, or devoid of sugar. Of general distribution, but not extensively cultivated. In quality the best varieties outrank all other root crops in the Philippines, and the yield is very satisfactory. Average starch content about 23 per cent. For low and medium elevations. (Pl. IV *b*, V *b*.)

Toqui, T. See Tongo.
Tubó, B., T., V. See Sugar cane.
Tugui, Il., T. See Tongo.

TURMERIC. *Curcuma longa* L.

A perennial herb about 1 meter high, with a fleshy, tuberous, aromatic rootstock, which, ground, furnishes the turmeric of commerce. Widely distributed in the Philippines, but cultivated only to a limited extent, and of no commercial importance.

TURNIP. *Brassica rapa* L.

A biennial herb, cultivated as an annual for its fleshy root, the leaves being used for greens. Native of Europe. May be

Coconut plantation in the Philippines.

grown at sea level for the leaves but an elevation of 600 meters is required for the production of fairly good roots. Above this elevation the quality of the roots is increased in proportion to the rise in altitude up to 1,200 meters where the turnip is very satisfactory.

Ubag, T. See Quirói.

UBI, B., T., V. *Dioscorea alata* L.

A perennial herb, native of India to Malaya, with a twining, robust vine, and large, underground tubers, cultivated as an annual, usually with bamboo poles for support. There are several distinct varieties in the Archipelago, varying in shape, size, color, and quality of the tubers, ranging from white to dark purple, globose to long and slender. Of universal distribution and largely cultivated, Bohol producing particularly good ubis. The second most important root crop in the Philippines. Average starch content 21 per cent, with some variation according to the variety. The following varieties are distinguished: Anayod, Biñang, Binúrac, Cabaloy, Caramisan, Iniog, Indappan, Polog, Pugang, Quinampay, Quinoro. Best adapted to low and medium altitudes.

Unas, Il. See Sugar cane.

UPO, T., V. *Lagenaria leucantha* Rusby.

A cucurbitaceous, annual, trailing vine, of which there are two distinct forms, usually trained to grow on a trellis or an arbor, and cultivated for its large fruits. Of general occurrence throughout the Archipelago.

Uve, Il. See Ubi.

†**YABIA**. *Tacca pinnatifida* Forst.

A perennial, stemless herb up to 1 meter tall, with a tuberous, starchy rootstock, sometimes 30 centimeters across, which yields an excellent starch. Starch content 22 per cent. Of wide distribution near the seashore throughout the Archipelago but rarely cultivated, and of practically no importance. Requires a light, friable soil. Quite extensively grown, and an important part of the diet of the natives in some parts of tropical Africa and Polynesia.

Yabyaban, T. See Yabia.
Yam. See the various species of *Dioscorea*.

***YAUTIA**. *Xanthosoma sagittifolium* Schott.

An herbaceous perennial, cultivated as an annual, native of tropical America. There are many varieties of recent introduction, but as yet of limited cultivation. Similar to the gabi

in appearance, culture and uses, but the yield is greater, and the starch content is somewhat higher, and the yautia is therefore worthy of more general culture. Has an average starch content of about 20 per cent, with wide variation according to variety.

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Zanahoria, Sp. See Carrot.

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Cochlearia armoracia L. Horseradish.
Codium tenue Kütz. Algae.
Coix lachryma-jobi L. Adlay.
Colocasia esculenta Schott. Gabí.
Coprinus ater Copel. Cabuti.
Coprinus confertus Copel. Cabuti.
Coriandrum sativum L. Coriander.
Corypha elata Roxb. Buri.
Cucumis sativus L. Cucumber.
Cucurbita maxima Duch. Squash.
Cucurbita pepo DC. Pumpkin.
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II.

FRUITS AND SPICES.

Abihid. See Lanno.
Abit, T. See Uay.
Achiote, Sp.-F. See Annatto.
Achuete, Sp.-F. See Annatto.

†**ADANG**, Ib. *Eugenia calubcub* C. B. R.

A shrub to a tree 10 or more meters high, of wide distribution. The fruits are 3.5 centimeters in diameter, pale yellow, fleshy, subacid, and of good flavor, borne among and below the leaves. Rarely cultivated.

Adiávan, T. See Coconut.
Aduas, T. See Lanno.
Afapúyan, Ib. See Banana.
Afúyan, Ib. See Banana.
Agas, T—A name applied to Alacao in Tagalog and to Camiring in Visayan.
Agat, Il. See Ginger.

†**AGLAÑO.** *Sapindaceæ.*

A medium-sized to large tree, 15 to 18 meters high, with compound leaves. The fruit is 5 to 6 centimeters in diameter, shaped somewhat like a peach, yellow, smooth, thin skinned, fleshy, subacid, and edible, but a trifle astringent, and contains two large seeds. The only known tree of this undescribed species, the edibility of whose fruit is not known to the Filipinos, grows in the ground of the College of Agriculture, Los Baños, Laguna. It has no native name, the above being proposed as a vernacular name.

Agobacbac, Mt. See Adang.
Agubac, T. See Calapi.

***AKEE.** *Blighia sapida* Koen.

A handsome tree of medium size, with pinnate, bright-green leaves, native of tropical west Africa. The fleshy, yellow arillus is eaten boiled, baked, or stewed in milk and afterwards browned with butter in a frying pan, and is of a rich nutty flavor. Care should be taken not to eat over-ripe fruit or poisoning may result. Of recent introduction.

Alacáac, T. See Alacáo.

†**ALACÁO**, P. *Palaquium philippense* C. B. R.

A rather large tree, with velvety, russet-colored leaves beneath, growing at low and medium elevations. The fruit is

somewhat similar to a small chico in appearance, 4 centimeters long; reported to be sweet, aromatic and of agreeable flavor. Recently domesticated.

Alácap, T. See Alácao.

†**ALAGA.** *Uvaria sorsogonensis* Presl.

A climbing shrub with large leaves, about 3 meters high, of wide distribution in low altitudes. The fruits are borne in clusters, oblong, semi-kidney shaped, salmon yellow, aromatic and edible. Not cultivated.

Alagan, Mt. See Orange.

†**ALEMANI**, Mt. *Vaccinium villarii* Vid.

A small shrub of upright growth 1 meter or more tall, found from Northern Luzon to Mindanao at elevations ranging from 1,000 to 2,900 meters. The small, black berries are produced in clusters of several, and are juicy, sweet, subacid and excellently flavored. Not in cultivation.

Alimíquin, Il. See Banana.
Alípay, T. See Alpay.
Al-la-allayat, Il. See Alaga.
Al-lagat, Il., (a generic term for all Uvarias).
Alluloy, T. See Galó.
Almendras, Sp. See Pili.
Aloco, Ib. See Baniti.

†**ALPAY**, T. *Euphoria cinerea* Radkl.

A small, attractive tree about 10 meters tall, with greenish fruits in loose clusters similar in shape to a small litchi; flesh whitish, sweet, juicy, and of good flavor. Of wide distribution, but rarely cultivated. Alsen (Mt.) a name applied in the generic sense to citrus fruits in some parts of the Mountain Province.

Alubíhon, T. See Lanno.
Alupac, T. See Alpay.
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Anagas-babac, T. See Manalú.
Anangui, B. See Pili.
Anáte. See Annatto.
Aníbong, V. See Coconut.

***ANIGLI.** *Annona senegalensis* Pers.

A shrub or small tree from tropical Africa, with fruits somewhat similar to a small custardapple, and scant, but sweet and aromatic flesh. Recently introduced.

Anilao. See Barobo.

ANNATTO. *Bixa orellana* L.

A small tree about 5 meters high, with terminal clusters of chestnut-burr-like, spiny fruits, containing a large number of small seeds used in the manufacture of cheese and butter dyes. Indigenous to tropical America. Of wide distribution, but of limited cultivation, and here of no commercial importance.

Anónas, Sp.-F. See Custardapple.
Anonóo. See Banana.
Ansa, Pa. See Manquil.
Antipólo, T. See Breadfruit.
Antipolong, T. See Breadfruit.

†ANTOL, Mt. *Garcinia vidallii* Merr.

A small to medium-sized tree up to 12 meters in height, of upright growth and large dark-green leaves. In shape the pale-green fruit resembles the mangosteen which it exceeds in size. The flesh is firm, acid, of pleasant flavor and would probably make a good preserve. Confined to regions with reasonably well distributed rainfall at low and medium elevations up to 900 meters. Rarely cultivated.

Anuáng, T. See Banana.
Anúblin, T. See Breadfruit.
Apalong, Ib. See Alpay.
Apalung, Ib. See Alpay.
Apas, Mt. See Calpi.

APPLE. *Pyrus malus* L.

A small to medium-sized tree, up to 10 meters high, native of Europe and Asia Minor, with roundish to oblate, green to yellowish, or more or less red-colored, smooth fruits, 6 to rarely exceeding 10 centimeters in diameter; white to yellowish, firm, subacid flesh of good to excellent flavor and quality. Of fairly satisfactory growth at an altitude of 1,500 meters. The trees in the Philippines are few, and all are seedlings. The quality of the fruit is poor.

***ARACÁ.** *Psidium guineense* Sw.

A shrub with round, small, greenish-yellow fruits, 1 to 2 centimeters across. Pulp red to white, of excellent flavor. Native to Brazil and the West Indies. Of recent introduction.

***ARGENA.** *Eugenia edulis.*

A shrub said to have edible fruits of good quality; introduced from Argentina. The above name is a contraction of Argentina.

Aricúndal, V. See Banana.
Arioat, Il. See Ayo.
Aropag, T. See Alpay.
Arráyan. See Guava.
Arupay, T. See Alpay.
Asuti, T. See Annatto.

***ATEMOYA.** *Annona* sp.

A small tree of rapid growth with fruits somewhat like the cherimoya in appearance but smaller, sweet, juicy, subacid, and of good to excellent quality, but a shy bearer. A hybrid between the cherimoya and sugarapple. Fruited for the first time at Lamao experiment station in 1913. (Pl. X, *b*.)

Áten. See Pili.
Ates, B., T., V. See Sugarapple.

†**ATIBU.** *Rubus pectinellus* Max.

A trailing plant with small leaves, and weak spines on all parts of the plant, growing at altitudes of and above 1,760 meters, from northern Luzon to Mindanao. Berries solitary, 2 or 3, 15 millimeters in diameter, enveloped in the spiny sepals until mature, bright red, juicy, subacid, and of excellent flavor and quality. The choicest species in the genus in the Philippines. Not in cultivation. The above name is an abreviation of the native name atibulnak.

Atibulnak, Mt. See Atibu.
Atilang, Mt. See Cubili.
Atimon, V. See Melon.
Atoangan, Mt. See Manquil.
Atola. See Annatto.
Attit, Ib. See Sugarapple.
Atsúiti, T. See Annatto.
Auinguay, Pa. See Alpay.

***AVOCADO.** *Persea americana* Mill.

A tree of medium size, frequently exceeding a height of 10 meters, native of the American Tropics; the fruits are very variable, from oblong and pear-shaped to round, greenish or reddish in various shades to almost black. The highly nutritious fruits, very rich in fat, are, in good varieties, of a nutty, very pleasant flavor, and are eaten raw with salt, pepper or sugar, or made into a salad.

The avocado was introduced by the Spaniards, but did not maintain itself nor gain favor with the Filipinos. All trees

now in the Islands have been introduced after the American occupation of the Archipelago. Has fruited for a number of years. (Pl. X, *a*).

Thirty-two budded varieties have recently been introduced, among which are included the following varieties: Baldwin, Cummins, Dickinson, Family, Largo, Lyon, Pollock, and Wester.

Ayagan, Mt. Mandarin.

†**AYO**, T. *Tetrastigma harmandii* Planch.

An attractive, evergreen, five-foliolate, tendril-bearing vine of vigorous growth; of wide distribution. The fruits, produced 4 to 10 in axillary clusters like the grape, are round, smooth, brownish in color, fleshy, juicy and acid, suitable for preserves. Cultivated as an ornamental.

Ayupag. See Alpay.
Babac, Ib. See Yambo.
Babana, V. See Guanábano.
Bacalao, Il., Z. See Alpay.
Bacaleo, Il. See Alpay.
Bacan, T. See Pangao.
Bacápie, V. See Calapi.

***BACHANG**. *Mangifera foetida* Lour.

A medium to rather large tree, indigenous to Malaysia, suited to a moist climate, with green, very aromatic, resinous fruits of the size of a large mango. Immature, the fruits are pickled, and mature, they are eaten like the mango, to which they are greatly inferior. Of recent introduction.

***BAEL**. *Aegle marmelos* Corr.

A small, spiny tree of Indian origin, with hardshelled, greenish, smooth fruits of about the size of a small pomelo, containing a sweet, rich, aromatic pulp, somewhat resembling the mabolo in flavor; eaten raw. Fruited for the first time at Lamao in 1914.

Bagabug, P. See Manquil.

***BAGEJA**. *Canarium moluccana* Bl.

A large tree, native of the Moluccas, quite similar in growth to the kanari, but having larger nuts about halfway in size between the kanari and pili, the kernels being of excellent flavor and quality. Recently introduced.

Bagó, V. See Banágo.
Bagó-Sili. See Banágo.
Bahag, Mt. See Lipote.
Bait, T. See Alpay.
Balabac, Z. See Lapini.
Balabal, Mt. See Manquil.

Balabar. See Dúhat.
Baláchbac, T. See Yámbo.
Balacbat, Il. See Lapini.
Balasugan, Ib. See Maigang.
Balaungan, Mt. See Palanau.

†**BALAUSAN**, Mt. *Eugenia* sp.

A tree up to 10 or more meters in height, with foliage quite similar to the manquil, but acid when tender. The fruit is borne among or just below the leaves in small clusters up to 5, and is said to be about 2.5 centimeters in diameter, red, fleshy, subacid and of good flavor. Occurs semicultivated in Kalinga, Mountain Province. Known also under the name of calobog.

Baláyang, Il. See Banana.
Balegan, B. See Maigang.
Baligang, B. See Lipote.
Balimbin, T. See Carambola.
Balimbíng, T. See Carambola.
Balimbingan, M. See Bulala.
Balingagta, Ib. See Mabolo.
Baliñgbíng, B., V. See Carambola.
Balinsiagao, Pa. See Bayante.
Balit, V. (a name used for both muling and alpay).
Balóbar, P. See Yámbo.
Balóbo, B., T. See Baróbo.
Balocboc, Z. See Lapini.
Balococ, Mt. See Binucao.
Balono, V. See Bauno.
Balonsaguing, V. See Alaga.
Báloy, T. See Banana.
Balsacan, T. See Muling.
Balubad, T. See Cashew.
Balubag, T. See Cashew.
Balubar, T. See Cashew.

†**BALUBAT**, T. *Eugenia* sp.

A shrubby tree with small, pale-red fruits and juicy, aromatic flesh that would probably make good preserves. Not in cultivation.

A name also applied to the cashew.

Balúbo, T. See Cashew.

†**BALUCO.** *Grewia edulis* Merr.

A tree up to 8 meters high, with fruits 2 centimeters in diameter, yellow, velvety, fleshy, subacid, and of good flavor. Not in cultivation.

Balucoc, T. See Baluco.
Balugug, M. See Barobo.
Balun, V. See Bauno.
Baluno, V. See Bauno.

†**BANAGO**, V. *Gnetum gnemon* L.

A tree attaining a height of 15 meters, of wide distribution in the Archipelago. The fruit is produced in small clusters and is oblong and pointed, rarely exceeding 2.5 centimenters in length, red and smooth, and containing one large seed that is eaten boiled or roasted, when they are of good flavor. Cultivated to a slight extent in Batangas and some of the Visayas.

BANANA. *Musa paradisiaca* L.

The banana is the most important fruit in the Philippines, is universally cultivated, and occurs in a greater number of varieties than any other fruit in the Archipelago. Lacatan, Latundan, Sabá, Gloria, and Buñgulan, are the most important varieties in the order of their enumeration, of which Buñgulan (Pl. IX, *a*) is the best in quality. Some of these varieties are eaten raw as a dessert fruit, while others should be cooked or fried in order to be palatable. The following 177 varieties, many of which are synonymous, have been collected in the various islands.

Agotay.
Alinsanag.
Amas.
Angao.
Asluman.
Balangun.
Balongcauit.
Baluco.
Banegas.
Bangaan.
Bangalan.
Bangaran.
Bangcayauan.
Bangkaiauan.
Batag ocay.
Binactin.
Binacule.
Binangay.
Binaoy.
Binato.
Binayasa.
Binuli.
Bocnoc.
Bongoyan.
Booi.
Boracho.
Bugtong.
Bulacon.
Bululan.
Bungan.
Bungolong.
Bungoran.
Bungulang pula.
Bungulan.
Bungulun.
But-uhan.
Cababa.
Calailay.
Calalay.
Calibo.
Calicot.
Calitan.
Canara.
Canaya.
Candaba.
Canipa.
Cantong.
Carandan.
Carao.
Cardava.
Cariñosa.
Carnaba.
Catep.
Consing.
Cuposa.
Daliao.
Daliring-guinoo.
Damilic.
Daraya.
Darian.
Dattok.
Dinalaga.
Dinaliri.
Doca.
Dojoy.
Dool.
Dulol.
Eda-an.
Enetlog.
Enosa.
Famotien.
Finipita.
Fob-olo señora.
Gadato.
Galamay señora.
Galayan.
Gapis.
Ginaring.
Gouyod.
Gugod.
Guinauit.
Guitlahin.
Gulian.
Guyod.
Guyud.
Higos.
Hinaligui.
Igos.
Inabaka.
Inabaniko.

Inambac.
Inarnibal.
Inatip.
Inog-og.
Ipod.
Kaalii.
Kadisnon.
Kanala.
Kilan-pilan.
Kinamay dalaga.
Kinaoit.
Kinarangian.
Kinayagan.
Lacatan.
Lacatan Sta. Cruz.
Lacnao.
Lalabon.
La Laguna.
Lapnao.
Latundan.
Lawit.
Lisohan.
Litondon.
Longsing.
Lubang.
Luboc.
Maching.
Malbaga.
Manang.
Mangamas.
Masecampo.
Matabia.
Matabia Lampong.
Maybay.
Mayoco.
Moco.
Morado.
Morong-datu.
Mundo.
Muradong pute.
Naglihim.
Obob.
Pagoja.
Palapaynon.
Pamoti-on.
Panono.
Paquel.
Payang.
Pelipita.
Pinaghabilinan.
Pitogo.
Plátano.
Po-ot.
Poriquit.
Principe.
Putian.
Raines-na-pula.
Raines-na-puti.
Rakadag.
Retundol.
Reynes.
Sabá.
Saba Iloco.
Sabang-billaco.
Sabang-Castilla.
Saba-Mariana.
Saba-Obispo.
Saksik.
Salebaguio.
Samanila.
Sapare.
Silangan.
Siñangil.
Sinom José.
Sisi-on.
Soybaguio.
Sulay Baguio.
Sungay-baca.
Taisok.
Talipa.
Tampihan.
Tanbunan.
Tancoñgon.
Tarusari.
Taub.
Tenombaga.
Tinalisay.
Tindoc.
Tinombaga.
Todoc.
Tomoc.
Tucon.
Tudlo-dalaga.
Tudlug-dato.
Tumbaga.
Tumoc.
Tundan.
Tundoc.
Tunsing.
Udding.
Ulipod.
Veinticohol.

†**BANAUAC**, T., V. *Uvaria rufa* Bl.

A semiscandent shrub, with oblong, reniform fruits 3 to 6 centimeters long, in bunches of 10 to 20, variable in flavor and quality. The best kinds have a whitish or semitranslucent, subacid pulp of agreeable flavor. Of wide distribution at low and medium elevations. Recently domesticated.

There are a number of other species in the genus with edible fruits, none of which are important or in cultivation.

Bañgal, T. See Banágo.

†**BAÑGAR**, Il. *Sterculia foetida* L.

A rather large, deciduous tree up to 20 meters in height, of rapid growth. The seeds are eaten like nuts, raw or roasted, and are of good flavor. The kernel is enclosed in a thin, leathery, tough skin rather than a "shell," and if more productive trees

with larger seeds than the average could be found this "nut" might have a commercial future in a limited way. Of wide distribution at low and medium elevations. Rarely cultivated.

Bañgquiling, T., V. See Iba.
Banilad, T. See Pangao.

†**BANITI.** *Garcinia dulcis* Kurz.

An evergreen, medium-sized tree up to 9 meters tall, with yellow, smooth fruits of about the size and shape of a small peach, about 5 to 7 centimeters in diameter, with a very acid, juicy, tender pulp, suitable for preserves. There is also a form having sweet fruits. Of wide distribution at low and medium elevations. Recently domesticated in the Philippines.

Banquilin, T. See Iba.
Bansalagin, T. See Kabikí.
Bansalágon, T., V. See Kabikí.
Baqueleo, Pa. See Alpay.
Barábag. See Yámbo.
Baracbac, Il. (in Ilocano used for the adang, in Tagalog for lapini.)
Barit, Ib. See Uay.

†**BAROBO**, V. *Diplodiscus paniculatus* Turcz.

A handsome tree of medium size, about 10 meters tall, the seed of which is boiled and eaten like the lima bean. Of wide distribution. Recently domesticated.

Bársic, T. See Kabikí.
Barúbo, B. See Baróbo.
Báseng, Il. See Ginger.
Basiad, T. See Pilí.
Basilalag, Mt. See Muling.
Bat, Ib. See Banana.
Batag, B. See Banana.
Batavia. See Banana.
Baticulin. See Dalinsi.
Batuan, B., V. See Binucao.
Batucanag, Il. See Bayante.
Batulan, T. See Jujube.
Baucoc, Mt., V., Z. See Binucao.

†**BAUNO**, V. *Mangifera verticillata* C. B. R.

A tree of medium to fairly large size, adapted to humid regions with abundant rainfall and periodical inundations. The fruit is obovoid, pale green, with white, somewhat fibrous flesh, subacid, quite variable, and in the best forms is somewhat larger than the mango, and of excellent quality; eaten as a desert fruit. Confined to Mindanao and the Sulu Archipelago.

Bayabas, T. See Guava.

†**BAYANI**, T. *Dillenia megalantha* Merr.

A medium-sized to large tree, averaging 15 meters in height, with dark-green, large, toothed leaves, 30 to 35 centimeters long, and large yellowish flowers, 10 or more centimeters in diameter. The fruit is 70 or more centimeters in diameter, the edible part consisting of the green, fleshy, juicy, and acid carpels, enclosed in the persistent sepals. Suitable for preserves. Native of the humid districts in Southern Luzon and the Visayas. Not in cultivation.

†**BAYANTE**, T. *Aglaia harmsiana* Perk.

A tree of medium size 10 to 15 meters high, of wide distribution. The leaves are 5 to 7 pinnate, the fruit 20 to 25 millimeters in diameter, round, velvety, vermilion red to russet colored; the flesh is reported to be of good flavor, resembling that of the cranberry, one-seeded. Produced in axillary clusters of up to 20 or more. Not in cultivation.

Bayauas, B., V. See Guava.

Báyet, T. See Alpay.

Bayog, V. See Bayante.

Bejuco, Sp. (A name employed in the generic sense for all rattans, such as calapi, litoco, tebdas, and uay, which see. The tender buds of many species are eaten as salad or boiled.)

***BERBA**. *Rheedia edulis* Planch. et Triana.

A tree of medium size about 15 meters high, indigenous to Central America. The fruit is shaped like an olive, about 2 centimeters in diameter, yellowish, with rather scant, edible flesh, in which are embedded 1 or 2 seeds. Of recent introduction.

†**BICA**, V. *Ampelocissus martini* Planch.

A tendriled vine with the leaves dark green above and russetted and velvety beneath, native of the lowlands of the Visayas and Luzon. The fruits grow in grape-like bunches, and are rather less than a centimeter in diameter, greenish salmon in color and are reported to be fleshy, acid and edible. Not cultivated.

†**BIGNAY**, T. *Antidesma bunius* Spreng.

A small, attractive, dark-green tree attaining a height of 10 meters, with small, dark-red, subacid, well flavored fruits in racemes like the currant. May be eaten raw and makes a fair jelly. Widely distributed. Rare in cultivation. A very distinct and superior variety is reliably reported from the Mountain Province.

Bilimbin, T. See Carambola.

Bilucao, T. See Binucao (a name applied to the katuri).
Binalaton, V. See Banana.

*__BINJAI.__ *Mangifera caesia* Jack.

A large tree, closely related to the bauno, of Malayan origin, with somewhat similar fruits. Succeeds under abundant rainfall. Recently introduced.

†**BINUCAO.** *Garcinia binucao* Choisy.

A small tree of wide distribution, with oblate, green, very acid fruits, 4 centimeters or more in diameter, containing several seeds. The fruit is eaten with fish by the Filipinos and would probably make a good preserve. Recently domesticated.

*__BIRIBA.__ *Rollinia orthopetala* A. DC.

A semideciduous tree of small to medium size and rapid growth. Native of northern Brazil and Guiana. The fruits are of about the size of the custardapple, heartshaped, with soft projections, green, with white, juicy, aromatic, subacid flesh of good quality. Of recent introduction. Fruited for the first time at Lamao in 1915.

Bisal, T. See Dalinsi.
Bísco, T. See Banana.
Bislot, T. See Lapini.
Bitangol, T. See Rukam.
Bitanhol. See Antol.
Bitbid, B. See Manquil.
Bitoñgon, T. See Bitungol.

†**BITUNGOL**, T. *Flacourtia sepiaria* Roxb.

A spiny shrub 1 to 3 meters high, with small, sweet fruits of agreeable flavor. Not in cultivation.

Bóboa, V. See Lanzon.
Bóbog, V. See Bangár.

†**BOBONÁO**, V. *Aglaia everettii* Merr.

A medium-sized to large tree with compound leaves, attaining a height of 10 to 20 meters, growing in the Visayas in the moist districts at low elevations. The fruits, produced in axillary clusters, are 4 to 5 centimeters long, roundish oblong, orange red, and contain a grayish, subacid, edible pulp. Not in cultivation.

Bococ, Mt. See Binucao.
Bocpoho, Mt. See Citron.
Bolen, Mt. See Antol.
Bolic. See Alpay.
Bolong, T. See Bitungol.
Bollógo, Il. See Cashew.
Bonganlabni, P. See Calápi.
Bonoa. See Lanzon.

Bonot, Mt. See Pangao.
Bonotán, V. See Coconut.
Boocán, V. See Lanzon.
Boongon, V. See Pomelo.
Bótong, V. See Coconut.

***BRAZIL NUT.** *Bertholletia nobilis* Miers.

A very large tree, exceeding 33 meters in height, bearing large fruits containing 18 or more nuts of excellent quality. Indigenous to Brazil and Guiana. Well suited to regions with abundant rainfall and great humidity. Of recent introduction (Pl. XII, *b*.).

BREADFRUIT. *Artocarpus communis* L.

A large, handsome tree up to 15 meters high, with large leaves, native of tropical Asia and Polynesia. There are two seed-bearing forms, and two seedless varieties, all of little importance, the first two because of the poor quality of the fruit, the latter because they are grown only to a very limited extent. The seedless fruit, baked, roasted or fried, is a nutritious and palatable food, and, because of its merits, should be a staple article in the local markets.

***BRITOA.** *Britoa acida* Berg.

A small to medium-sized tree, 6 to 9 meters high, of Brazilian origin, related to the guava, but somewhat larger than this fruit, round, pale yellow, acid, and suitable for preserves.

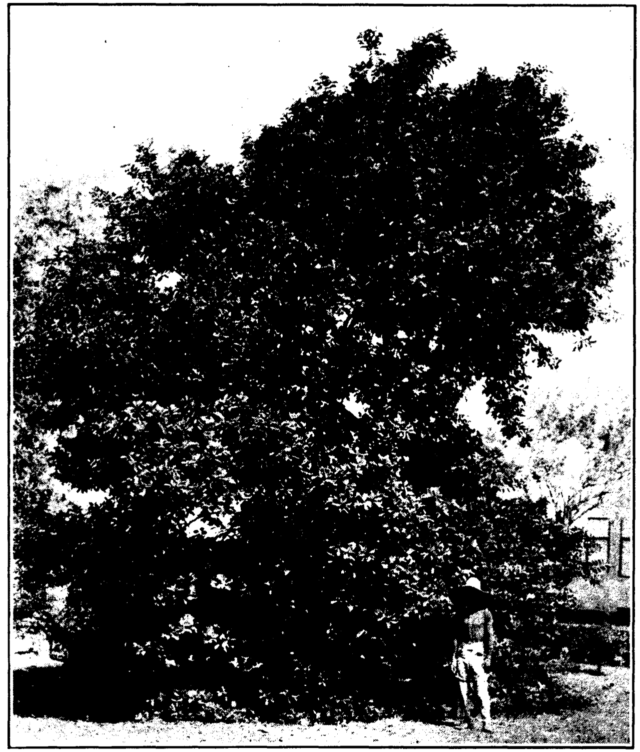
Buabua, T. See Manquil.
Buáhan, M. See Lanzon.
Bub-búgnay. See Bignay.
Bubua, V. See Bobonao.
Bucad, M. See Barobo.
Buccalao, Il. See Alpay.
Bugatot, V. See Antol.
Buglay, Mt. See Bignay.
Búgnai, B., V. See Bignay.
Bulahan, V. See Lanzon.

†BULÁLA, B., T. *Nephelium mutabile* Bl.

A medium-sized tree bearing fruits in loose clusters like the litchi, but somewhat larger, short-oblong, reddish brown, with hard, erect, short spines; in cultivated varieties sweet, subacid and juicy, of excellent quality, eaten out of hand as a dessert fruit. From northern Luzon to Mindanao in humid districts at low elevations. Rarely cultivated.

Buli, M. See Bulala.
Bulog, V. See Bobonao.
Bulubi. See Barobo.
Bunag. See Katuri.

(*a*) Liberian coffee, *Coffea liberica*, at the Lamao Experiment Station, 1916.



(*b*) Maté *Ilex paraguariensis*. Singalong Experiment Station, 1916.

(*a*) A field of the Cayenne pineapple. Lamao Experiment Station.

(*b*) A strawberry field at the former Trinidad Experiment Station, Baguio, Benguet.

Buneg, Il. (a name used for both baniti and katuri.)
Bunguas, V. See Bobonao.
Bunlauan, V. See Yambo.
Bunnéc, Il. See Banana.
Bunot-bao, Il. See Tibao.
Bunug, Pa. See Antol.
Bunutan, Ib. See Paho.
Buragris, B. See Binucao.
Burauis. See Dalinsi.
Buru, M. See Barobo.

***BURUNG**. *Baccaurea dulcis* Muell. Arg.

A tree of Malayan origin bearing an edible fruit. Of recent introduction.

Butnéng, Il. See Banana.
Buyon, Mt. See Antol.
Cabiquí, T., V. See Kabikí.
Cabugao, Mt. See Guyod.

†**CABUYAO**, Pa., T. *Citrus histrix* DC.

A small, thorny tree 5 to 6 or more meters high, with rather large, roundish, lemon-colored fruits about 8 centimeters in diameter, very acid, and eaten with fish by the Filipinos; may be made into a fair "ade." A very variable species of wide distribution, seldom cultivated. In Central Luzon the above name frequently refers to the calpi.

CACAO, Sp. *Theobroma cacao* L.

A small tree, 4 to 6 meters high, the source of the cacao of commerce. Indigenous to tropical America. Well distributed throughout the Archipelago. It is estimated that in 1915, 1,169 hectares were planted to cacao. There are no large cacao plantations in the Philippines.

Café, Sp. See Coffee.
Cagél, Sp.-F. See Orange.
Cagoco, M. See Manquil.
Cahâna, M. See Coffee.
Cahél, B., T., V. See Orange.

***CAIMITILLO**. *Chrysophyllum oliviforme* Lam.

A small, handsome, West Indian tree, the leaves dark-green above and russetted beneath. The fruit is very similar to the dalinsi in size and shape, dark purple, smooth; the flesh is sweet and edible but rather insipid. Recently introduced.

Cajocko, V. See Manquil.
Calamansali, T. See Dalinsi.
Calamansanoy, Z. See Rukam.
Calamansé, T. See Calamondin.
Calamasali, Z. See Rukam.
Calamías, T. See Camia.

†**CALAMONDÍN**, T. *Citrus mitis* Blanco.

A small, ornamental tree, 4 to 6 meters tall, of common occurrence, with round, thin-skinned, mildly acid fruits, up to 4 centimeters in diameter; may be used in making ade or for marmalade.

Calaotit, Ib. See Dalinsi.

†**CALÁPI**, T. *Calamus ornatus* var. *philippinensis* Becc.

A coarse, spiny, climbing rattan of vigorous growth, with large leaves, and stout, hooked, rather sparse spines, growing in the Visayas in low and medium altitudes up to 600 meters. The fruits grow on branched and arching racemes and are about 3 centimeters long, oblong, scaly, yellowish with dark markings; flesh semi-transparent, acid, and makes an excellent jelly. Recently domesticated (Pl. IX, *b*.)

Calinbagín, T. See Guava.
Calit-calit, T. See Ayo.
Calmay. See Iba.
Calmuyas, T. See Camia.
Cálo. See Gomíhan.
Calobcob. See Adang.
Calompán, T. See Bangár.
Calómpit, T. See Dalinsi.
Calo-oy, V. See Cabuyao.
Calotib, Mt. See Alemani.

†**CALPI**, B. *Citrus webberii* Wester.

A small to medium-sized, handsome tree, 5 to 10 meters in height, the better forms having oblate, very juicy, acid fruits, up to 65 centimeters in diameter, somewhat resembling the mandarin; may be used like the lemon. Particularly abundant in the Mountain Province, Nueva Vizcaya and southern Luzon where it is common in cultivation. A very variable species. (Pl. X, *c*.)

Calubcub, T. See Adang.
Calugcog. See Adang.
Calumagon, B. See Dalinsi.
Calumánog, V. See Dalinsi.
Calúmpag, T. See Bangár.
Calumpáng, T. See Bangár.
Calumpit, T. See Dalinsi.
Calumpit-na-puti, T. See Muling.
Calúngpang, T. See Bangár.
Calupay, Z. See Alpay.
Calupi, Ib. See Dalinsi.
Calusit, Ib. See Dalinsi.
Camagón, B., T. See Mabólo.
Camagúan. See Mabólo.

Camalágui, V. See Tamarind.
Camalitos, T. See Limoncito.

CAMANCHÍLE, T. *Pithecolobium dulce* Benth.

A medium-sized tree, 6 to 15 meters high, of Mexican origin, widely distributed and cultivated for its pods which contain a white, sweet, edible pulp.

Camandies. See Camani.
Camangsi, T. See Binucao.

†**CAMANI**. *Garcinia rubra* Merr.

A shrub or small tree rarely exceeding 10 meters in height with rather small leaves, occurring from southern Luzon to Mindanao. The fruits, produced in the axils of the leaves, are nearly 3 centimeters in diameter, subrotund, somewhat flattened, yellowish to red, fleshy and edible. Not in cultivation.

Camanitiis, B. See Camani.
Camias, T. See Camia.
Camansíle, B., T. See Camanchíle.
Camantaris, Il. See Camanchíle.
Camaris. See Dalinsi.
Camastéles, V. See Camanchíle.

CAMIA. *Averrhoa bilimbi* L.

A small tree, 5 to 10 meters high, with oblong, greenish, very acid fruits, 4 to 6 centimeters long, produced on the stem and larger branches, suitable for preserves. Native of Tropical Asia. Commonly cultivated. A form with sweet fruits has recently been discovered.

Camias, T. See Camia.
Camilíng. See Baróbo.
Caming, P. See Camiring.

†**CAMIRING**, Il. *Semecarpus cuneiformis* Blanco.

A shrub or small tree up to 6 meters high, of wide distribution. The fruit resembles the cashew in form but is smaller, and is red, fleshy and edible. Not cultivated.

Camisan, V. See Tamisan.
Camochíle. See Camanchíle.
Camoning, T. See Limoncito.
Camonsil, V. See Camanchíle.
Camuling, T. See Muling.

†**CANCI**, V. *Citrus histrix* var. *boholensis* Wester.

A small, thorny tree, rarely exceeding 4 meters in height, with oblate, juicy, acid fruits, a little smaller than the calpi; may be used like the lemon and makes a fair ade. Rare in cultivation.

Candangisol, B. See Alpay.
Candies, M. See Camani.

Candis, T. See Binucao.
Canining pute, T. See Coraiap.
Cantol, Mt. See Santol.
Canumay, Il. See Binucao.
Capáyas, T., V. See Papaya.
Capitan, Ib. See Mandarin.
Caractón, V. See Banana.

CARAMBOLA. *Averrhoa carambola* L.

A small tree, about 5 meters high, of restricted cultivation, native of tropical Asia, bearing 5-angled, semitranslucent, acid fruits, 6 to 7 centimeters long, suitable for preserves. Trees with subacid fruits that may be eaten out of hand with relish are occasionally found.

Carameras, T. See Coraiap.

***CARAUNDA.** *Carissa carandas* L.

A large, thorny shrub, of Indian origin, with roundish oblong, black fruits of about the size of the ciruela, but with dark-red, acid flesh, containing a number of small, flat seeds. Excellent for preserves. Of recent introduction. Fruited for the first time at Lamao in 1915.

An unidentified species of *carissa* closely related to the caraunda has been introduced and fruited at Lamao, the fruit of which is of excellent quality.

***CARDAMON.** *Amomum cardamomum* L.

A perennial, aromatic herb, one meter or more high, the dried seeds of which furnish the cardamon of commerce. Recently introduced.

***CARISSA.** *Carissa arduina* Lam.

A thorny, spreading shrub of medium size, native of South Africa, with oblong or round, red fruits, 3.5 to 4.5 centimeters long, juicy, subacid, and well flavored. May be eaten out of hand or preserved. Recently introduced. Fruited for the first time at Lamao in 1914.

Carmay, T. See Iba.
Carnáte, V. See Banana.

CAROB. *Ceratonia siliqua* L.

A shrubby, small, dioecious tree, native of the Levant, bearing dark-brown pods very rich in sugar; an excellent cattle feed. Noted only in Dapitan, Department of Mindanao and Sulu.

Carobcob. See Adang.
Carogcog, B. See Yambo.

CASHEW. *Anacardium occidentale* L.

A small tree of wide dissemination, but not extensively cultivated, of which there are two varieties, with red and yellowish fruits, respectively. Native of the American Tropics. The fruit is eaten raw and may also be made into ice cream; the seeds are of good flavor and may be eaten like nuts, raw or roasted.

***CASIMIROA.** *Casimiroa edulis* LaLl.

A medium-sized tree, of Mexican origin, with fruits similar to the baniti in size and shape, but with cream-colored, firm, sweet, aromatic flesh, inclosing several large seeds. Used as a dessert fruit. Recently introduced.

Casóy, B., T., V. See Cashew.
Castañas, T. See Galó.
Casuy, T., V. See Cashew.
Catapang. See Antol.

†**CATMON**, B., T., V. *Dillenia philippinensis* Rolfe.

An ornamental, medium-sized tree 6 to 12 or more meters tall, with compact crown and dark-green leaves. The edible part of the fruit, greenish, acid and juicy, excellent for preserves, is inclosed in the persistent sepals and contains a few small seeds. Of wide distribution but rarely cultivated.

The name catmon is in some parts of the Islands also applied to the palali.

Catmon carabao, T. See Palali.
Catolit, Mt. See Baniti.

***CATTLEY.** *Psidium cattleianum* Sabine.

A tall Brazilian shrub or small tree, with a dark-red, smooth fruit, about the size of a large lanzon, subacid, and of good flavor, containing numerous small seeds. Excellent eaten out of hand or in preserves. Both this and the yellow cattley, *P. c.* var. *lucidum*, have fruited at Lamao.

Caumpáng, M. See Bangár.
Cayacuat, Mt. See Guava.
Cayam. See Kayam.

***CAYMITO.** *Chrysophyllum cainito* L.

An attractive tree, indigenous to the American Tropics, with dark-green leaves, russetted beneath. The fruit is the size of a large chico, smooth, with translucent, vinous, subacid pulp of good flavor. Eaten as a dessert fruit.

Cayococ, B. See Lapini.
Cayogpug. See Adang.

*CEFALUS. *Sarcocephalus esculentus* Afzel.

A semiscandent, spreading shrub of vigorous growth, native of tropical West Africa. The fruit is roundish, brownish and rough, about 6 centimeters across, with reddish, juicy, edible pulp. Recently introduced. "Cefalus" is taken from the generic name.

*CERIMAN. *Monstera deliciosa* Liebm.

A large, creeping or climbing aroid, with oblong fruits, 15 to 20 centimeters long, with an exterior somewhat recalling a pine cone; native of Central America and Mexico. The flesh is white, juicy, subacid, of excellent flavor and quality, and nearly always seedless. Used as a dessert fruit. Recently introduced.

*CHERIMOYA. *Annona cherimolia* Mill.

A small tree, 5 to 10 meters high, adapted to high elevations, 750 meters and above, bearing a heart-shaped fruit, subacid, juicy, and deliciously flavored, similar to or larger in size than the custardapple. Native of Mexico. Recent introductions include the "Giant," "Golden Russet" and several other varieties.

CHESTNUT. *Castanea sativa* Mill.

An attractive tree of medium to large size, attaining a height of 15 to 25 meters, indigenous to the Mediterranean countries and eastward to China. The nuts, 1 to 3, contained in a spiny husk, commonly referred to as a burr, are excellent roasted.

A tree in Mankayan, Mountain Province, has fruited for many years, and young trees in Sagada at an altitude of about 1,300 meters are in flourishing condition.

CHICO, Sp.-F. *Achras sapota* L.

A small tree 6 to 8 meters high, with roundish or egg-shaped, variable, russetted, sweet, well flavored fruits, 4 to 6 centimeters long; native of Central America and the West Indies. Cultivated to considerable extent for the Manila market. Of general distribution in the Archipelago.

CHICO-MAMEY. *Lucuma mammosa* Gaertn.

A medium-sized tree of vigorous growth, best suited to districts with fairly equal distribution of rainfall; of Central American origin. The fruit is quite like a very large, oblong chico in appearance. The pulp somewhat resembles reddish-brown, thick marmalade, and is sweet and aromatic. Rare, and confined to Laguna and Cavite.

Chuaguy, Mt. See Duguay.

Cídra, Sp. (Sometimes also employed to designate the dalayap). See Citron.

Caliñgíwa, V. See Camia.

CINNAMON. *Cinnamomum zeylanicum* L.

A tree of medium to large size, 15 to 20 meters high, native of Ceylon and South India, the bark of which is collected and dried, in which form it is disposed of in the world's markets. Found at medium elevations in Cavite, and probably elsewhere. Of no commercial importance.

Ciniguelas, B., T., V. See Ciruela.

CIRUELA, Sp. *Spondias purpurea* L.

A small, spreading, deciduous tree about 6 meters high, of general distribution and quite extensively cultivated. Native of tropical America. The fruit, of the size of a cherry, a little longer than broad, contains a large seed but is of good flavor and is eaten as a dessert fruit. Two forms occur, one with dark-purple, and the other with yellow fruits.

Cirúllas. See Ciruela.

CITRON. *Citrus medica* L.

A thorny shrub up to 3 meters high, native of the mainland of southeastern Asia, with large, oblong, yellow fruits, the thick peel of which is candied and eaten. Rarely cultivated.

Coco, Sp. See Coconut.

COCONUT. *Cocos nucifera* L.

A large palm attaining a height of 25 meters, believed to be a native of tropical America. Extensively cultivated for its large nuts, consumed locally or made into copra and coconut oil, and for palm wine, made of the sap from the flower buds; by far the most important fruit in the Philippines. (Pl. VI.) Adapted to elevations ranging from sea level to 800 meters, with a rainfall of fairly equal distribution, rather humid atmosphere, and no periods of extraordinary droughts. The following varieties are distinguished: Agtá, Bulao, Burawis, Busag, Dahili, Inano, Laguna, Liadmon, Lonó, Lupisan, Macapunó, Mañgipod, Niño, Pugai, Romano, Tataguden, Tutupaen, and there are probably other unrecorded forms. Among the varieties enumerated the Romano, or San Ramon, as it is also called, and the Laguna, are the best varieties for copra and oil production; the Macapunó is a small nut with a solid, not hollow kernel, but of somewhat softer texture than the ordinary coconut. The Pugai, known in the various dialects as Cayománis, Cuyámis, Tapiásin, Tában, Tamisan, and Pangosin, has a sweet, juicy husk, which is chewed for its sugar content.

During 1915, 264,148 hectares were planted to coconuts, averaging 200 trees to the hectare. From these were obtained the same year 72,441,158 ripe nuts for local consumption, valued

at $1,048,940; copra, 171,573,963 kilos, value, $9,188,592; coconut oil, 3,175,626 liters, value, $331,245; palm wine, 51,372,213 liters, value, $1,662,164.

In 1915, the following were the leading coconut provinces with the number of trees in cultivation and value of the produce: Tayabas, 8,256,167 trees, $1,907,288; Laguna, 4,759,564 trees, $1,490,130; Department of Mindanao and Sulú, 4,674,291 trees, $1,181,536; Albay, 3,920,492 trees, $1,009,488; Ambos Camarines, 2,669,089 trees, $695,138; Samar, 3,449,361 trees, $512,744.

***COFFEE-ABEOCUTA.** *Coffea abeocuta* Cramer.

A small tree of upright growth, and quite large, dark-green leaves, closely related to the Liberian coffee, and of similar requirements and quality, but of somewhat lower yield, commanding the same price as the Liberian coffee; blight and drought resistant. Native of Africa, recently introduced.

COFFEE-ARABIAN. *Coffea arabica* L.

A small tree, 4 to 5 meters high, native of southwestern Asia, the seeds of which constitute the coffee of commerce. Common throughout the Islands, but of no importance except in the highlands of Mindanao and northern Luzon, and even there the production is limited owing to the coffee blight, *Hemileia vastatrix*. Succeeds well with a short, well marked, dry season, and should not be planted where the rains coinicide with the flowering period. Recommended for planting only between elevations of 800 and 1,500 meters. Average yield under good culture 400 kilos per hectare. The estimated area under cultivation in 1915 was 840 hetcares.

***COFFEE-CANEPHORA.** *Coffea canephora* Pierre.

A coffee closely related to the robusta, and of similar requirements and quality; blight resistant. Native of Africa. Recently introduced.

***COFFEE-CONGO.** *Coffea congensis* Froehn.

A small tree of good growth, native of Africa, resistant to the coffee blight; succeeds best under the same conditions as the robusta coffee. Requires artificial drying; of recent introduction.

***COFFEE-EXCELSA.** *Coffea excelsa* Chev.

A small tree of African origin, of robust growth and large leaves, closely related to the Liberian coffee, adapted to low and medium elevations up to 700 meters, and succeeds well even on clayey soils; yield slightly lower than that of the Liberian coffee; blight and drought resistant. Requires artificial drying. Prop-

erly prepared the coffee is of good quality and commands a good price. Recently introduced.

COFFEE-LIBERIAN. *Coffea liberica* Hiern.

A small tree of upright growth, native of Africa, blight resistant and quite drought resistant; adapted to elevations at and below 350 meters, succeeding well even on rather heavy, clayey soils. Average yield between 600 and 700 kilos per hectare. Requires artificial drying. Properly prepared the coffee is of good quality and commands a good price. (Pl. VII, *a*.)

***COFFEE-QUILLOU.** *Coffea quillou.*

A species of African origin, similar to the robusta, and of similar requirements and quality, but more uncertain as to yield. Recently introduced.

***COFFEE-ROBUSTA.** *Coffea robusta* L. Linden.

A small tree, from tropical Africa, adapted to a reasonably friable, fertile soil with abundant rain and no prolonged dry periods; may be grown from sea level to an elevation of 1,000 meters, but succeeds best at an altitude ranging from 450 to 700 meters; blight resistant. Not considered equal in quality to Arabian and Liberian and related coffees. Very precocious and prolific, with a yield of 875 to sometimes exceeding 1,800 kilos per hectare, but requires artificial drying to command a profitable price in the market.

***COFFEE-UGANDA.** *Coffea ugandæ.*

A small tree, of African origin, closely related to the robusta coffee, which it resembles in appearance and requirements, but to which it is somewhat superior in resistance to the *Hemileia* and to adverse conditions. The coffee requires artificial drying and equals the robusta in quality. Recently introduced.

Colcolnog, Mt. See Pangao.

†**COLIAT**, T. *Gnetum latifolium* Bl.

A large, woody vine, of wide distribution in low and medium elevations. The fruits are similar to those of the banago, but larger, and the nuts are roasted or boiled and eaten like the banago. The hairy skin should be carefully removed before the nut is eaten. Not in cultivation.

Collogo, Il. See Cashew.
Cólo, V. See Gomíhan.
Colonâuas, T. See Camia.
Comantiris, V. See Camanchíle.

†**CONNACON**, Mt. *Eleocarpus calomala* Merr.

A spreading tree, 7 or more meters in height, of rather rare occurrence, distributed from northern Luzon to the Visayas at

medium elevations. The fruits grow in clusters of 3 to 5 or more, on the bare branches, and are 3 to 3.5 centimeters long and 2 or more centimeters in diameter, purplish red to almost black, smooth, with red flesh, rather dry, subacid, and somewhat astringent. Eaten out of hand raw and would probably make a good preserve. Not in cultivation.

Copahan, V. See Cabuyao.

†**COPELA.** *Rubus copelandii* Merr.

A robust-growing bramble with ascending, arching, spiny, trifoliate canes, sometimes exceeding 3 meters in length, at elevations of and above 1,750 meters in northern Luzon. Berries in clusters, nearly 2 centimeters across, orange red, fairly juicy, and edible, but lacking in flavor. Not cultivated. The above name is an abbreviation of the specific name.

Copen, Mt. See Orange.

†**CORAIAP.** *Aglaia glomerata* Merr.

A small to medium-sized tree, from 5 to 12 meters tall, with odd pinnate leaves. The fruits are produced 3 to 6 or more, in axillary clusters, and are round, up to 25 millimeters in diameter, orange red and velvety, with edible pulp. From Luzon to Mindanao; not cultivated.

***CORICA.** *Coccoloba* sp.

A tree related to the seagrape, bearing small, very acid fruits, said to make good preserves. Recently introduced from Costa Rica. The above name is a contraction of the name of this country.

Coriguelas, V. See Ciruela.

***COS.** *Psidium friedrichsthalianum* Ndz.

A medium-sized tree, 8 to 12 meters high, indigenous to Mexico and Central America, with small, roundish, very acid fruits, suitable for preserves. Of recent introduction.

†**COTMO.** *Vaccinium whitfordii* Merr.

A shrub or small tree 1 to sometimes exceeding 7 meters in height, of upright growth and small leaves. The fruits are produced singly in the axils of the leaves and are small, black, juicy, subacid, sweet and of excellent flavor. Found in the Mountain Province in altitudes above 675 meters. Not cultivated.

Cotmóc, B. See Dalinsi.

†**CUBILI**, T. *Cubilia blancoi* Bl.

A medium-sized tree, with compound leaves, attaining a height

of 8 meters or more, of wide distribution, but not abundant, in the forests at low and medium elevations. The fruit is roundish oblong, 5 to 6 centimeters long, bright green, spiny, and contains a roundish-oblong nut about 3 centimeters long, of excellent quality, roasted or boiled. Of recent domestication (Pl. XII, *c.*)

†**CULIA.** *Cinnamomum culiawan* Bl.

A shrub or small tree, native of Mindanao and the Sulu Archipelago. The bark is collected and used by the Filipinos as a substitute for cinnamon, to which it is inferior. The bark was collected and exported during the Spanish regime, but is now of no commercial importance. Not in cultivation. The name is an abbreviation of the specific name.

Culiát, V. See Coliat.
Culuris. See Alpay.
Cumbug, M. See Catmon.
Cupcup. See Adang.

CUSTARDAPPLE. *Annona reticulata* L.

A small, semideciduous tree, 5 to 7 meters high, of West Indian origin, with a brownish-yellow, heart-shaped fruit, 8 centimeters or more in diameter, containing a cream-colored, sweet, juicy pulp of good flavor, but inferior to the sugarapple. Common in cultivation in Luzon; sparsely distributed in the Visayas and Mindanao.

***CYNDRA.** *Cyphomandra betacea* Sendt.

A semiherbaceous perennial shrub, from subtropical South America, of rapid, vigorous growth and large leaves. The fruits, produced in terminal clusters in great profusion, are broadly ellipsoid, 3 to 4.5 centimeters long, smooth, reddish yellow to deep purple, fleshy and succulent, subacid, and of agreeable flavor eaten fresh, stewed or made into jam. Introduced in 1911 but subsequently lost. For medium elevations; also worth trying in the high altitudes. The above name is a contraction of the generic name.

Dacad, Mt. See Pineapple.
Dagingdingan, V. See Alpay.
Daiamiras, T. See Bayante.
Dalandán, T. See Orange.

DALAYAP, Mt. *Citrus limetta* var. *aromatica* Wester.

A spiny shrub, rarely exceeding 4 meters in height, with arching branches. The fruit is very similar to the lime, round to somewhat longer than broad, usually a little larger than the lime, to which it is similar in flavor but inferior, usually very seedy. Of wide distribution and common in cultivation.

The name dalayap is sometimes also applied to the citron, lime and calpi.

Daligan, Il. See Carambola.
Dalíma, M. See Pomegranate.

†**DALINSI**, T. *Terminalia edulis* Blanco.

A rather ornamental, large tree, up to 25 meters in height, of wide distribution. The fruits are dark-red, smooth, about 3 centimeters across, resembling somewhat a plum, fleshy and acid, and would undoubtedly make a good preserve. Recently domesticated.

Dambuhala, T. See Manquil.

***DAMIA**. *Macadamia ternifolia* Muell.

A small tree of Australian origin, with dark-green, stiff leaves, bearing nuts somewhat smaller than the filbert which are of excellent quality. Adapted to elevations ranging from 300 to possibly above 1,000 meters. "Damia" is taken from the generic name.

Damortís, Il. See Camanchíle.
Daracan, Il. See Alacao.

DATE. *Phoenix dactylifera* L.

A medium-sized, dioecious palm, producing the commercial date, indigenous from Northern Africa to India. The fruit is produced in large bunches frequently exceeding 25 kilos in weight. Only a few trees are known in the Philippines; reported from Bohol to bear good fruit abundantly. Best adapted to the dry districts of the Archipelago.

Dayáp, T. (a name sometimes applied also to the limoncito). See Lime.
Deguay, Mt. See Duguay.

***DERMA**. *Annona sclerodermа* Saf.

A small tree, native of Guatemala, having roundish, hard-shelled fruits, 7.5 centimeters in diameter, reported to contain a soft, custardlike pulp of good flavor. Of recent introduction. "Derma" is taken from the specific name.

Dingin, Z. See Catmon.
Dinugúan, T. See Banana.
Disit, Ib. See Dalinsi.
Dokog. See Rukam.
Dúat, P., T., V. See Dúhat.

†**DUGUAY**, Mt. *Saurauia bontocensis* Merr.

A shrub or a tree, up to 9 meters high, with long, dark-green leaves, occurring at medium elevations up to 1,300 meters in northern Luzon. The fruit is 4 to 5 centimeters in diameter, flattened, smooth, yellowish, subacid, juicy, with numerous, small

seeds and said to be of good flavor; borne in clusters in the axils of the leaves, and on the bare branches and the trunk. Not in cultivation.

DUHAT, P., T., V. *Eugenia jambolana* Lam.

A medium to large tree, 8 to 15 meters high, bearing a dark-purple to black, oblong fruit about the size of a small grape, containing a large seed; native to tropical Asia. The flesh is rather scant, subacid and of good flavor, and makes a superior jelly. Very generally distributed and marketed in considerable quantities in season. Large-fruited forms exist, and a seedless variety of good quality has recently been discovered.

Duían. See Durián.

***DUKU.** *Lansium domesticum* Jack. var. *duku.*

A small to medium-sized tree, somewhat larger than the lanzon, of symmetrical growth, adapted to regions with abundant and equally distributed rainfall. The fruit is round, 3.5 to 4.5 centimeters across, with whitish, translucent, subacid flesh of delicious flavor and quality; eaten as a dessert fruit. Of recent introduction.

Dulían, M. See Durían.

DURIÁN. *Durio zibethinus* L.

A large, handsome tree up to 20 meters high, with leaves silvery beneath, adapted to moist districts with abundant rainfall of equal distribution; native of Malaysia. The fruit is large, sometimes exceeding 3 kilos in weight, the whitish, buttery, sweet, aromatic flesh being confined in a hard, bony and spiny "shell." Rather rare in cultivation, and, recent introductions excepted, confined to Mindanao and the Sulu Archipelago.

Estiuitis, V. See Annatto.

EUGENIA. *Eugenia* spp.

In addition to those discussed in this publication there are about ten or twelve species of *Eugenia* indigenous to the Philippines that are reported to be edible, but about the fruit of which no reliable data are available.

E-wah, M. See Camia.
Falooc, Mt. See Pomelo.

***FEIJOA.** *Feijoa sellowiana* Berg.

A large shrub adapted to elevations above 800 meters, indigenous to Paraguay and southern Brazil. The fruit somewhat resembles a guava in appearance and size but is greatly superior to the latter in flavor and quality. Recently introduced. (Pl. XII, *a.*)

FIG. *Ficus carica* L.

In the Philippines a small straggling shrub bearing inferior fruits. Of rather rare occurrence. Indigenous to Syria and northern Africa.

Folen, Mt. See Antol.

†**GALÓ**, T. *Anacolosa luzoniensis* Merr.

A tree of medium size about 15 meters high, with simple leaves; of rather rare occurrence, found from northern Luzon to the Visayas, at low and medium elevations. The fruit, produced in the axils of the leaves, is a nut about the size of a filbert, and is of good flavor and quality. Of recent domestication.

There are several other imperfectly known species of *Anacolosa* the nuts of which are probably also edible.

Galangan, V. See Carambola.
Galuran. See Carambola.
Garangan, V. See Carambola.
Garcinia, *Garcinia* spp. (There are a number of species in this genus aside from those discussed in this paper, but imperfectly known, and reported to have edible fruits.)
Gatasan, T., V. (In Tagalog applied to katuri, in Visayan to baniti.)
Gauid, Mt. See Guyod.
Gayaba, Mt. See Pomelo.
Gayaet, Mt. See Guava.
Gayumayen, Z. See Dalinsi.
Gayunan, Mt. See Pomelo.

***GENIPA.** *Genipa americana* L.

A large tree, of West Indian origin, bearing a grayish to brownish fruit somewhat resembling a lemon in shape but about three times as large, containing a tough, very aromatic, subacid pulp, with the flavor of fermenting apples, enclosing many seeds; said to make a good cooling drink. It makes a good jelly and a fair sherbet and icecream. Fruited for the first time at Lamao in 1913.

Gimma, Mt. (In certain districts of the Mountain Province applied in the generic sense to all citrus fruits.)

GINGER. *Zingiber officinale* L.

A perennial herb with a creeping underground rootstock, which dried, forms the ginger of commerce. Cultivated to a slight extent in central Luzon, but of no commercial importance.

Givagava, Z. See Coconut.
Gogolat, Mt. See Kinubo.
Golod, Mt. See Calpi.

†**GOMIHAN**, B. *Artocarpus elastica* Reinw.

A tree of medium to large size, sometimes exceeding a height

of 15 meters, adapted to regions with abundant rainfall fairly equally distributed. The fruit is of the size of a very small bread-fruit (of the seedy form), and contains a sweet, edible pulp of fair to good quality, embedded in which are numerous seeds that roasted may be eaten like peanuts. Recently domesticated.

Gonod, Mt. See Calpi.
Goyabano, Sp.-F. See Guanábano.
Goyóran, T. See Banana.
Granada, Sp. See Pomegranate.

GRANADILLA. *Passiflora quadrangularis* L.

A climbing vine of very rapid growth, and large, pale-green fruits shaped somewhat like the citron but smaller; native of tropical America. Of limited cultivation. The Philippine varieties are rather insipid and of poor quality.

***GRAPE-MUSCADINE.** *Vitis rotundifolia* Michx.

A vine indigenous to southern United States, with thick-skinned grapes, solitary, to rarely more than 4 in a bunch, of good quality. The following varieties have been introduced: Eden, Flowers, James, Labama, Lasalle, Mish, San Jacinto, San Melaska, and Thomas.

GRAPE-VINIFERA. *Vitis vinifera* L.

Only one rather primitive variety of this species, with greenish, small grapes in small bunches, is cultivated, mostly in Cebu, though isolated vines are found in most provinces. Native of southern Europe.

***GRUMICHAMA.** *Eugenia brasiliensis* Lam.

An arborescent, large shrub, attaining a height of 4 to 6 meters, of Brazilian origin, with dark-red to purplish, roundish fruits, about 2.5 centimeters across. The flesh is sweet and of agreeable flavor. Recently introduced.

GUANÁBANO, Sp. *Annona muricata* L.

A small, attractive, dark-green tree about 5 meters tall, native of the West Indies, with large, oblong, green fruits with soft spines, sometimes exceeding 5 kilograms in weight. The flesh is white, rather fibrous, juicy, pleasantly acid and of good flavor; eaten as a dessert fruit, made into sherbet or preserved. Here the most widely cultivated species in the genus.

GUAVA. *Psidium guajava* L.

A tall shrub or small tree, 4 to 6 meters high, native of the American Tropics, with roundish, variable fruits, averaging 4 centimeters in diameter, which may be eaten out of hand and

make excellent preserves. One of the most generally distributed fruits in the Islands, but of practically no commercial importance.

Guayába, Sp. See Guava.
Guayábo. See Guava.
Guin-guin, T. See Longan.

***GUISARO.** *Psidium molle* Bertol.

A shrub of medium size, native of Central America and Mexico, bearing small, round fruits, up to 18 millimeters across, subacid, aromatic and of excellent flavor. May be eaten as a dessert fruit or preserved. Of recent introduction. Fruited at Lamao in 1916.

Guisihan, T. See Alpay.
Guisoc. See Barobo.
Gulod, Mt. See Calpi.
Gumíhan, B. See Gomíhan.
Gumíhan, B. See Gomíhan.
Guyába, Sp. See Guava.
Guyabano, T. See Guanábano.

†**GUYOD**, Mt. *Citrus webberii* var. *montana* Wester.

A very attractive tree 7 or more meters high, nearly related to the calpi, distinguished chiefly by its drooping, slender branches, and larger, more or less wrinkled fruit, which is inferior to the calpi as an ade fruit. Known only from northern Luzon, where it is semicultivated.

Habana. See Guanábano.
Hagasan, V. See Bayante.
Halupag, T. See Alpay.
Hangos. See Tulana.

***HEVI.** *Spondias cythereæ* Sonn.

A large, deciduous tree 15 to 20 meters high, from Polynesia, with amber-colored subacid, aromatic fruits, of about the size of a large hen's egg, containing a large seed; fruits in large, loose clusters. The fruits are of good flavor and may be eaten out of hand. Of recent introduction. Fruited for the first time at Lamao in 1915.

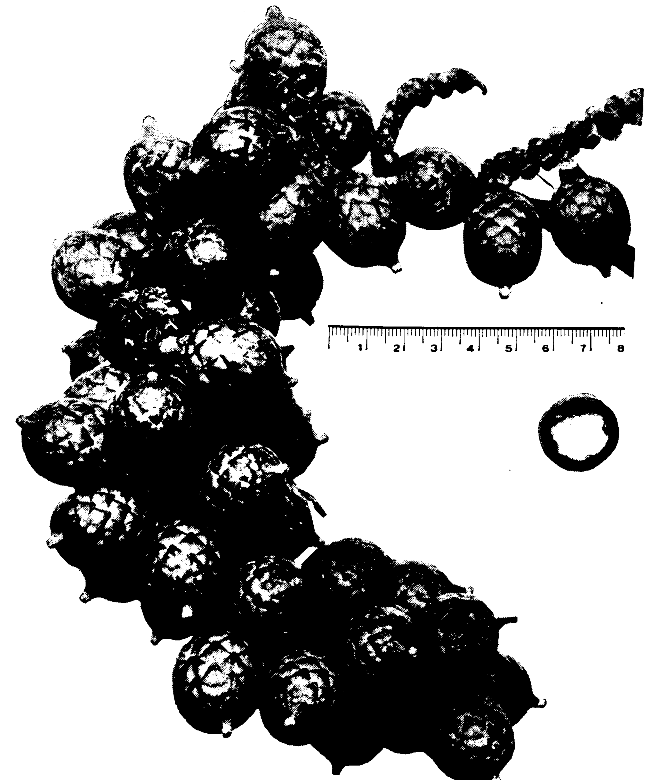
*(?)**HONDAPARA.** *Dillenia indica* L.

A handsome, compact, medium-sized tree with green, smooth fruits about the size and shape of the kambog; native of tropical Asia. The fruit is acid and is made into jelly and cooling drinks, but is inferior to the nearly related catmon and palali. Has fruited in Manila for several years.

Huampít. See Wampi.
Huckleberry. See Alemani and Cotmo.
Hungo, T. See Connacon.
Huyo, B. (Used in a generic sense for all rattans.)

PLATE IX

(*a*) The "Bungulan" banana.



(*b*) Calapi, *Calamus ornatus* var. *philippinensis*.

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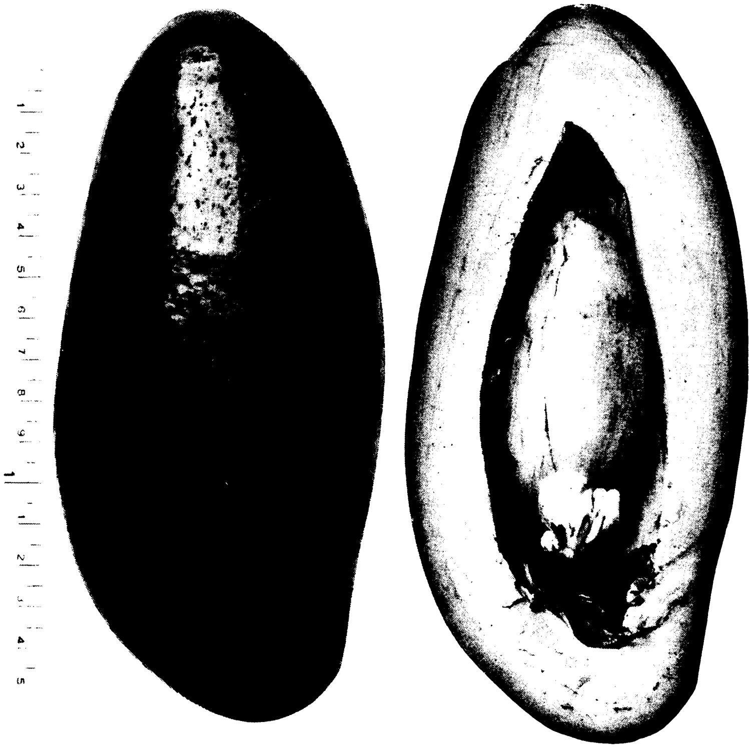
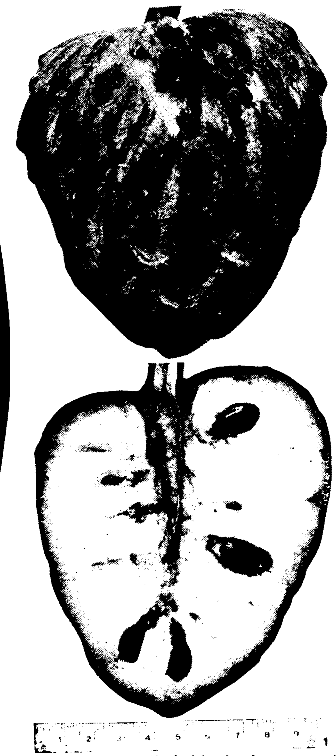
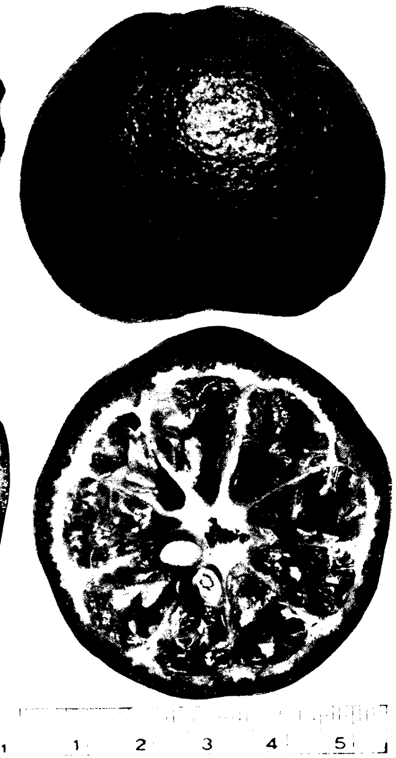
PLATE X.



(*a*) Avocado, *Persea americana*, grown at the Lamao Experiment Station.



(*b*) Atemoya (hybrid cherimoya and sugarapple), grown at Lamao Experiment Station.



(*c*) Calpi, *Citrus webberii.*

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IBA, B., T., V. *Cicca disticha* L.

A small tree, 6 meters or more high, bearing the fruit on the stem and coarse branches and twigs in currantlike racemes, indigenous to southeastern Asia and Polynesia. The fruit is about as large as a small grape, ribbed, pale green, smooth, very acid and contains one rather large seed. Two crops of fruit produced annually. Excellent for jelly and various preserves and makes a good ade. Sparingly cultivated.

The camia is also known under the name iba in Tagalog, Moro, and Visayan.

Ibule, T. See Cubili.

***ICACO**. *Chrysobalanus icaco* L.

A shrub of medium size, from tropical America, with dark-purplish, smooth, subacid fruits of fairly good flavor, resembling the ciruela in size and shape, containing one large seed. Of recent introduction.

Iddulu. See Camia.
Igos, Sp. See Fig.
Igot. See Lipoti.
Illuru, Ib. See Camia.
Iniw, Z. See Banauac.
Isip, P. See Bignay.
Ituman, V. See Mabolo.
Iva, V. See Camia.

JAK. *Artocarpus integra* L.

A small, to medium, dark-green tree, rarely exceeding 12 meters in height, with large, yellow, oblong fruits suspended from the trunk and large branches, indigenous to India and Malaya. The jak is the largest tree-fruit known in the world, the fruit sometimes exceeding 35 kilos in weight, and is one of the most widely cultivated fruits in the Philippines. The flesh is a rich yellow in color, sweet and very aromatic; it makes a good preserve and is excellent candied.

Jamo, B. See Tersana.
Jangus, V. See Manquil.
Jantac, Ib. See Pangao.
Jengibre, Sp. See Ginger.

†**JUANI**. *Mangifera odorata* Griff.

A medium to rather large tree, confined to Mindanao and the Sulu Archipelago, adapted to a climate with abundant rainfall evenly distributed. The fruits are of about the size of a mango, but shorter and rounder, green, sweet and juicy, very aromatic, and very resinous, and much inferior to the mango in the Philippines.

Juanita, M. See Juani.

JUJUBE. *Zizyphus jujuba* L.

A medium to large, thorny tree, 6 to 18 meters high, best adapted to elevations above 500 meters; native of tropical Asia. The fruit is smooth, yellowish, quite like the ciruela in size and shape, and contains one large seed. Dried, the improved foreign varieties are excellent. The jujube is sparingly grown in the Philippines and the fruit is very poor.

†KABIKI, B. *Mimusops elengi* L.

An attractive tree of medium to large size, up to a height of 15 meters, of compact growth. The fruit is roundish oblong, about 3 centimeters long, reddish, fleshy, sweet, aromatic and edible. Of wide distribution, but rarely cultivated. The native fruits are very poor.

Kaddog, Mt. See Binucao.
Kaguku, M. See Manquil.

***KAIAPPLE.** *Aberia caffra* Hook. f. et Harv.

A large, thorny shrub or small tree, from South Africa, with roundish to somewhat flattened, greenish-yellow, smooth, rather acid fruits, 3.5 centimeters or more across; makes excellent preserves. Adapted to elevations at and above 800 meters. Of recent introduction.

Kakel, Mt. See Mandarin.

KAKI. *Diospyros kaki* L.

A small, deciduous tree, native to Japan and China, adapted to altitudes of 800 meters or more, bearing roundish to flattened, smooth, orange-red fruits about the size of a small mabolo. The flesh is rich, red yellow, sweet, and of excellent flavor and quality. Occasional trees are found in the Philippines.

Kalomahi, Mt. See Tamarind.
Kalsaang, Mt. (A name also used for a fruit-bearing, unidentified species of *Eugenia* in the Mountain Province.) See Pomelo.
Kalumagon. See Dalinsi.
Kambog, M. See Palali.

†KAMI. *Cinnamomum mindanaense* Elm.

A tree of medium size, 10 meters tall, growing at medium elevations in Mindanao, the bark of which is collected to a slight extent and sold as cinnamon.

Kamoling. See Muling.

***KANARI.** *Canarium commune* L.

A large, attractive tree, native to the Sunda Isles, adapted to regions with abundant and well distributed rainfall. The fruit is a nut, a little smaller than the pili, containing 2 to 3 kernels of excellent flavor and quality raw or roasted.

†**KATURI**, Ib. *Garcinia venulosa* Choisy.

A tree of medium size, about 12 meters high, with oblong leaves, and of wide distribution in low and medium altitudes. The fruits are axillary or terminal, 4 to 6 centimeters in diameter, subrotund, somewhat flattened, green, acid, containing several flat seeds. Eaten with fish by the Filipinos, and would probably make a good preserve. Recently domesticated.

KAYAM. *Inocarpus edulis* Forst.

A medium to large, handsome tree with kidney-shaped pods, containing a large bean; of Polynesian origin. Boiled before they are quite ripe the beans are said to resemble a chestnut in flavor and are very nutritious. Succeeds best where the rainfall is of equal distribution with no prolonged dry periods. Rarely cultivated.

***KECHAPI**. *Sandoricum radiatum* King.

A large tree, native of Malaysia, bearing a fruit quite similar to the santol but smaller. Of recent introduction.

***KETEMBILLA**. *Aberia gardnerii* Clos.

A small, shrubby tree, indigenous to Ceylon, with large, velvety berries, about the size of the lanzon, of pleasant, acid flavor, containing a number of small seeds. Excellent for preserves. Recently introduced. Fruited for the first time at Lamao in 1916.

†**KINUBO**, Mt. *Rubus moluccanus* L.

A trailing, flexible, slender bramble, with canes 2 to 3 meters long, short spines and leaves russetted beneath. Of wide distribution, occuring from northern Luzon to Palawan and Mindanao, at altitudes of 500 to 1,100 meters. The fruit is small, 1 centimeter in diameter, red, juicy, sweet and edible but insipid in flavor. Not cultivated.

Kinubot, Mt. See Kinubo.

***KLEDANG**. *Artocarpus lancaefolia* Roxb.

A small, upright tree, native of Malaysia, bearing edible fruits. Of recent introduction.

Kopjao, Mt. See Tersana.

***KUCHING**. *Nephelium malaiense* Griff.

A tree bearing an edible, very little-known fruit, native of Malaya. Of recent introduction.

***KUMQUAT**. *Citrus japonica* Thunb.

A shrub or small tree 2 to 4 meters high, probably a native of Cochin-China, with roundish to oblong, orange-yellow fruits,

3 centimeters or more in diameter, with a sweet, edible rind and acid pulp. Eaten raw or preserved. Of recent introduction. Should be grown at or above an elevation of 300 meters.

***KUNDANGAN.** *Bouea macrophylla* Griff.

A tree of Malayan origin, with fleshy subacid fruits somewhat larger than the dalinsi. Recently introduced.

Labnit, B. See Calápi.
Laccangan, Il. See Tulana.
Laguinata, M. See Palanau.
Laioan, B. See Iba.

***LAMUTA.** *Cynometra cauliflora* L.

A small tree, native of Malaya, usually with several trunks, on which are borne the fleshy, wrinkled, subacid, pleasantly flavored pods, which are suitable for preserves, and which would probably make a good jelly and ade. Recently introduced.

Lanca, T. See Jak.
Langca, B., Il., V. See Jak.

†LANNO, Ib. *Spondias pinnata* Kurz.

A rather tall, deciduous tree of wide distribution, bearing yellowish, sweet, edible fruits of about the size of a large ciruela, to which it is inferior. Rare in cultivation.

Lansóne, B., T. See Lanzon.
Lanu, Ib. See Lanno.
Lanutan, T. See Mabolo.

LANZÓN. *Lansium domesticum* Jack.

A small, handsome tree, 5 to 8 meters high, bearing the fruit on the stem and larger branches, in bunches like the grape; native of Malaysia. The fruits are considerably larger than the grape, velvety, and contain a translucent, subacid pulp of excellent flavor. Eaten as a dessert fruit. Of local distribution in Mindanao, Cebu, and Laguna. Requires abundant rain of equal distribution for good success. May be grown up to an altitude of 750 meters, but the best fruits are produced at low elevations. Cultivated quite extensively in Laguna for the Manila Market.

†LAPINI. *Eugenia xanthophylla* C. B. R.

A medium-sized to quite large tree 20 meters in height, nearly related to the yambo; of wide distribution in low and medium elevations. The red fruits, 2.5 centimeters in diameter, borne in terminal or axillary clusters, are fleshy and edible. Not in cultivation.

Lapinig, B. See Lapini.
Lapnisan, V. See Muling.
Lapote, T. See Maigang.

***LAURIVA.** *Psidium laurifolium* Berg.

A shrub or small tree, native of Central America. The fruit is quite large, 4.5 centimeters across, acid and resinous, and edible. Of recent introduction. "Lauriva" is a contraction of "laurel gruva."

Layál, Z. See Ginger.
Layóhan, V. See Iba.

***LEMASA.** *Artocarpus polyphoema* Pers.

A small tree, native of tropical Asia, somewhat similar to the jak. The fruit resembles a small jak which it is said to surpass in quality. Recently introduced.

LEMON. *Citrus limonum* Risso.

A small, shrubby, spiny tree, 3 to 6 meters in height, the source of the commercial lemon, probably native to India or adjacent countries to the east. The native varieties are very poor and the fruit is rarely marketed. The following standard varieties have been introduced: Belair, Messina, Lisbon, Lisbon Variegated, Sicily, Thornless, and Villa Franca.

Libas, B., M., T. (In some parts of Mindanao this name also applies to antol.) See Lanno.
Ligas, T. (A name applied both to Camiring and Manalú, which see.)
Ligayan, M. See Kabiki.

LILIKOI. *Passiflora edulis* Sims.

A perennial climber of vigorous growth, of Brazilian origin. The fruit is roundish-oblong, 6 centimeters long, purplish, smooth, the edible part yellow, sweet, juicy and of good flavor, and contained in the shell-like rind. Whipped with sugar and a small amount of bicarbonate of soda this is said to make a delicious drink. The plant grows well at sea level but requires an elevation of 700 meters to fruit well. Has fruited abundantly at Baguio during the last few years. Rare in cultivation.

Limbaón, V. See Coconut.

LIME. *Citrus limetta* Risso.

An arborescent, thorny shrub, 3 to 4 meters high, native of India and adjacent countries to the east, with greenish to lemon-yellow, roundish fruits, containing a pleasantly acid pulp that makes excellent ade. Of general distribution throughout the Philippines, but mostly of poor quality. The following standard

varieties have been introduced: Bengal, Everglade, Kusaie, Tahiti, and Trinidad.

Limon, Sp., T. (More specifically applied to the lemon and *Citrus medica* var. *nanus* Wester, but also employed to designate other acid citrus fruits, such as the lime, dalayap, citron, calpi, *Citrus excelsa* and its variety *davaoensis*.)

Limonáto. See Limoncito.

LIMONCITO. *Triphasia trifolia* P. Wils.

A spiny shrub of medium size, up to 3 meters high, native of south China, with small, dark-red, sweetish, somewhat resinous fruits, which are very good candied. Of general distribution but sparsely cultivated. Erroneously reported to be exported from Manila.

Limoncitos, B. See Limoncito.

LIMON-REAL, Sp. *Citrus excelsa* Wester.

A large, thorny shrub of vigorous growth, up to 5 meters high, with oblate, greenish to lemon-yellow fruits, a little smaller than the mandarin. Of fairly general distribution but not extensively cultivated. The fruit is mostly very poor but occasional trees are found the fruit of which is unexcelled for ade. A subspecies, *C. excelsa* var. *davaoensis,* with very large, mamilate fruits occurs in Davao, Mindanao.

Limoran, T. See Calapi.

Limuran, T. See Calapi.

†**LIPÓTI**, T. *Eugenia curranii* C. B. R.

A tree of medium size, 9 meters or more high, well adapted to humid regions with abundant and equally distributed rainfall. The fruits, up to 20 millimeters in diameter, growing in compact clusters on the bare branches and mature twigs, are round, dark red to black in color, rather dry, but of a pleasant, acid flavor. Eaten out of hand and made into wine, and would undoubtedly make good preserves. A white-fruited form occurs sparingly. Of wide distribution at low and medium elevations from northern Luzon to the Visayas but rarely cultivated.

LITCHI. *Litchi chinensis* Sonn.

A handsome tree of medium size, with dense foliage, of Chinese origin. The fruit, about the size of a small plum, is produced in loose bunches; the translucent, pleasantly acid, juicy pulp, enclosing a large seed, is contained in a red, warty, thin shell. Of good quality, eaten out of hand or dried. The litchi has been sparingly introduced for several years in low altitudes but has never fruited. Would probably succeed better at elevations above 300 meters.

†**LITOCO**, Mt. *Calamus* sp.

A climbing, spiny rattan, with rather coarse stem, attaining a height of 10 meters or more, bearing a round, scaly fruit in large, branched racemes. The fruit, which ripens in the last months of the year, is said to attain a size of 30 millimeters or more in diameter, and to have a semi-translucent, juicy, subacid pulp of good flavor, separating readily from the flesh, good eaten out of hand as a dessert fruit. Seeds 2 to 3. Found at medium elevations in Kiangan, Ifugao, northern Luzon, and Nueva Vizcaya.

Litu-u, Ib. See Litoco.
Lóbi, V. See Coconut.
Lóbi-nga-hinbâon, V. See Coconut.
Lobiñga-pilípog, V. See Coconut.
Lombóy, T., V. See Dúhat.

LONGAN. *Euphoria longana* Lam.

A handsome, small to medium-sized tree, up to 12 meters in height, with purplish fruits, containing a scant, acid pulp, suitable for preserves. Native of India to south China. Of rare occurrence in the Philippines.

*__LOQUAT__. *Eriobotrya japonica* Lindl.

A small, evergreen tree, up to 5 or more meters high, with thick, dark-green leaves, native of China and Japan. The fruit, growing in terminal clusters of 8 to 15 or more, is roundish oblong, 3 or more centimeters long, brownish yellow, more or less velvety with yellowish subacid, juicy flesh of excellent flavor and quality. Succeeds well at and above an elevation of 300 meters. Of rare occurence chiefly in Cavite and the Mountain Province.

*__LOUVI__. *Flacourtia inermis* Roxb.

A tree of medium to small size, native of Malaya, with small, red, acid berries, which make a good jelly and preserves. Fruited for the first time in 1914 with Mr. W. S. Lyon, Manila.

Lubacán, V. See Coconut.
Lubas, B. See Lanno.
Lubí, V. See Coconut.
Lubilubili, T. See Cubili.
Lucban, T. See Pomelo.
Lukban, T. See Pomelo.
Lumbói, Il., T., V. See Dúhat.
Lumbonao, V. See Bobonao.
Lupac, B. See Alpay.
Lupal, M. See Alpay.
Lurad, Ib. See Calpi.
Luting, Mt. See Palanau.
Lúya, B., T., V. See Ginger.

†**MABÓLO**, T. *Diospyros discolor* Willd.

A tree of medium size, 8 to 15 meters high, with dark-green leaves. The fruit is roundish to a trifle flattened, about 75 millimeters in diameter, or of about the size of a large apple, velvety, reddish, with cream-colored, rather dry, sweet and aromatic flesh, containing several large seeds. There is also a form with brownish fruits, and trees with seedless fruits of good quality have recently been noted. One of the most common fruits in the Philippines.

Macaasim, T. See Manquil.
Macasampáloc, T., V. See Tamarind.

MACOPA, T. *Eugenia javanica* L.

A tree of medium size, up to 10 meters or more in height, with cone-shaped, 3 centimeters or more long, pink, very pretty fruits, but dry and tasteless. Native of tropical Asia. Fairly well distributed.

Madang. See Marang.
Magiono, V. See Tulana.

†**MAIGANG**, V. *Eugenia polycephaloides* C. B. R.

A tree of medium size, 15 to 20 meters high, with young growth four angled and at times slightly winged; nearly related to the lipote, and distributed from northern Luzon to the Visayas at low and medium elevations. The fruit grows in clusters on the bare branches just below the twigs, and is a little more than 1 centimeter across, dark red, acid and edible.

Mala-canasi, B. See Mamata.
Malacupa, V. See Adang.
Mala-dayap, T. See Mamata.
Malapato, V. See Paho.
Malahaguis, B. See Manquil.
Malaruhat, Z. See Manquil.
Malasángui. See Cinnamon.
Malasantol, V. See Bobonao.
Malatampoy, V. See Lapini.
Malatápay, T. See Mabolo.
Malatumbaga, T. See Mayante.
Malinbin, V. See Carambola.
Malisa, B., T. (A name applied to the pineapple in Bicol and to pepper in Tagalog.)
Malono. See Bauno.

***MALPI**. *Malpighia glabra* L.

An unattractive West Indian shrub, with red, acid, round fruits about the size of a small lipote, which make excellent jelly. Recently introduced. Fruited for the first time in 1916

at the Lamao experiment station. "Malpi" is an abbreviation of the generic name.

Malúbo, T., V. See Baróbo.

†**MAMATA**. *Lansium dubium* Merr.

A small tree, 4 to 7 meters high, with compound leaves, occurring at low elevations in moist districts from southern Luzon to Mindanao and the Sulu Archipelago. The fruit is 25 millimeters in diameter, round, brownish yellow, and said to be edible. Not in cultivation. "Mamata" is an abbreviation of the vernacular name "Mamata-babas."

Mamata-babas, V. See Mamata.

**MAMEY*. *Mammea americana* L.

An attractive, spreading tree attaining a height of about 15 meters, with dark-green, leathery, shining leaves, native of tropical America. The fruit is 7.5 to 12 centimeters across, roundish to flattened, russetted, and contains a reddish-brown, rather firm, sweet flesh, and 2 to 4 large seeds. The fruit is quite variable, some varieties being reported to be of excellent quality. Of recent introduction.

Mamicahan. See Barobo.

***MAMÓN**. *Annona glabra* L.

A medium-sized, semi-deciduous tree, 6 meters or more high, with fruits somewhat similar in appearance to the custard-apple, juicy and acid, but resinous and barely edible. Native of tropical America and Africa. Quite variable. Recently introduced. Fruited for the first time at Lamao in 1913.

Mampálan, M. See Mango.

†**MANALU**, V. *Semecarpus gigantifolia* F. Vill.

A tree about 10 meters tall, of wide distribution, unbranched or with few branches, with broad, long leaves, frequently exceeding one meter in length, which give the plant a striking, palmlike appearance. The fruits, produced in great abundance on the trunk, in panicles 10 to 20 centimeters long, resemble somewhat the cashew in shape, and are 3 to 4 centimeters long, deep purple in color, fleshy, juicy and edible, but somewhat astringent. Not in cultivation.

Manáyao. See Baróbo.

***MANDALIKA**. *Artocarpus rigida* Bl.

A tree of Malayan origin related to the jak, bearing a large, edible fruit. Recently introduced.

MANDARIN. *Citrus nobilis* Lour.

A small tree, 4 to 6 meters in height, usually with several trunks, native of Cochin-China. The fruit is roundish, to more or less flattened, greenish to orange red, thin skinned, sweet and juicy, and of excellent quality. The most generally cultivated species in the genus, and well disseminated throughout the Archipelago, but has assumed commercial importance only in Batangas Province. Commercially the third most important fruit in the Philippines, ranking next to the banana. The following standard varieties have been introduced: China, Dancy, King, Kishiu, Ladu, Oneco, Satsumamikan, Suntara Nagpur, Unshiu.

Manga, T., V. See Mango.
Mangabu, M. See Barobo.
Mangala, M. See Katuri.
Mangcopa, V. See Tersana.

MANGO. *Mangifera indica* L.

A large handsome, spreading tree, native of India and Malaya, bearing a more or less kidney-shaped, sweet, rich and juicy fruit, in the Philippines of very good to excellent quality. The best Philippine mangos probably excel those in all other countries. In quality the Philippine forms, which come true to seed, rank in the following order: Señora, Carabao, Pico (syn. Padero), and Pahutan (syn. Chupadero and Supsupen). The mango is the fourth most important fruit in the Philippines and the following provinces lead in mango production in the order of their enumeration: Cavite, Nueva Ecija, Cebu, Pangasinan, Bohol, and Zambales. The mango does not fruit in the humid districts of the Islands, and other related species that do so, such as the bauno, bachang and binjai, should there be planted instead of the mango. (Pl. XI, *a* and *b*.)

Ripe, the fruit may be eaten out of hand or preserved. Green, it is pickled, or may be boiled and used like apple sauce; it also may be utilized in making a cooling drink.

The following varieties have been introduced from India: Alfonso, Bombay green, Chickna, Davy's favorite, Gopalbhog, Kachamitha, Kakaria, Kutna, Krishna bhog, Langra, Malda, Naspati, Najibabadi amin, Sandurea, Salibunda, Sufaida, Surkha, Tamancha.

Manggá, B., T., V. See Mango.
Manggis, M. See Mangosteen.

MANGOSTEEN. *Garcinia mangostana* L.

A small, attractive tree, 6 to 7.5 meters high, with dark-green foliage, native of Malaysia; in the Philippines confined almost entirely to Mindanao and the Sulu Archipelago, and adapted to

a humid climate, with abundant rains well distributed throughout the year. The fruit is roundish to a trifle flattened, dark red or purplish, and about 6 centimeters in diameter. The flesh is snow white, sweet, exquisitely flavored, and separates entirely from the rind. One of the best fruits in the Philippines.

Manguis, M. See Mangosteen.
Mangustan, Sp. See Mangosteen.
Maninila, B. See Binucao.

†**MANQUIL**. *Eugenia mananquil* Blanco.

A tall tree, 7 to 20 meters in height, with prominently veined leaves; of wide distribution. The fruits, borne in great profusion on the trunk and large branches, are about 4 centimeters long, ovoid, red, fleshy, acid, and of good flavor.

In the open this makes a very attractive shade tree, having a dense, well rounded crown of dark-green foliage. The above name has also been erroneously applied to *Eugenia javanica* in various publications.

Mantilit, Ib. See Camanchile.
Manzána-rosa, Sp. See Yambo.
Manzana, Sp. (the name manzana is also applied to the jujube). See Apple.
Manzanitas, Sp.-F. See Jujube.
Maobo, V. See Barobo.
Maraman, Il. See Barobo.

†**MARANG**. *Artocarpus odoratissima* Blanco.

A handsome tree of medium size, and large, lobed leaves. The marang ranks third in size among the Philippine tree fruits being exceeded in size only by the jak and the coconut, and is about equal to the durian. The flesh is white, sweet, very rich, juicy, and aromatic, and the marang is undoubtedly the best dessert fruit in the genus. Confined to Mindanao, the Sulu Archipelago, Basilan, and Mindoro.

Maranguis, Mt. See Bulala.

***MARÓN**. *Annona montana* Macf.

A semideciduous tree, from the West Indies, rarely exceeding 10 meters in height, with dark-green, malodorous leaves. The fruit is roundish, averaging about 8 centimeters in diameter, greenish, with short, sparse spines, and yellowish, rather cottony, acid pulp. Inferior to the guanabano. Of recent introduction. Fruited at Lamao for the first time in 1915.

Marubo, B. See Barobo.
Mata-mata, B., M. (Applied to alpay in Moro and to the bayante in Bicol.)
Matangutang, T. See Bayante.
Matobato, V. See Galó.

***MASTIC.** *Sideroxylon mastichodenron* Jacq.

A tree of medium size, native of Florida and the West Indies, with yellow, smooth, sweet, juicy, aromatic fruits of good flavor, about the size of a lanzon. Of recent introduction.

***MATÉ.** *Ilex paraguariensis* St. Hil.

A large, evergreen, arborescent shrub, native of Paraguay and Southern Brazil, with dark-green leaves, which are dried and used in making a beverage like tea, called maté or Paraguay tea. (Pl. VII, *b*.)

Midbid, T. See Manquil.
Midbit, T. See Manquil.

***MIRIM.** *Rollinia emarginata* Schlecht. (?)

A slender, handsome shrub or tree, 3 to 10 meters in height, native of Brazil and Paraguay. The fruit is rather small, 2.5 centimeters or more in diameter, reported to be edible Recently introduced.

***MITNAI.** *Artocarpus* sp.

A tree of robust and rapid growth, introduced from Cochin-China, said to have an edible fruit. Of recent introduction.

***MOMBIN.** *Spondias lutea* L.

A deciduous tree of medium size, rapid growth and brittle wood, native of the American Tropics. The fruit is considerably larger than the ciruela, yellowish, subacid, and of good flavor, containing a large seed.

Moras, Sp. F. See Mulberry.
Moyong, Mt. See Pomelo. (A name also applied to a species of a fruit-bearing *Eugenia* in the Mountain Province.)

MULBERRY. *Morus alba* L.

A medium-sized, spreading, deciduous tree with black, subacid fruits of good flavor, native of Central Asia to China. The tree grows well down to sea level but requires an altitude of 750 meters in order to produce good fruit. Well disseminated.

†**MULING**, T. *Grewia stylocarpa* Warb.

A tree of medium to large size, from 6 to sometimes exceeding a height of 15 meters, of wide distribution. The fruit is pyriform, 1.5 to 3 centimeters long, yellowish, fleshy, subacid, apple flavored, and said to be of excellent quality; produced in terminal or axillary clusters of 3 to 5 or more. Not in cultivation.

Muling-muling, T. See Baróbo.
Munkinkil, T. See Manquil.

MUSKMELON. *Cucumis melo* L.

An annual, trailing vine in general cultivation for its large

fruits. Several varieties are grown, but the melons, though of normal size, are generally poor and devoid of flavor.

Namot, Il. See Muling.
Nancá, T. See Jak.
Nangca, I. See Jak.
Naranjítas, B., T., V. See Mandarin.
Naránja, Sp. (In some provinces applied to the pomelo.) See Orange.

***NELLI.** *Phyllanthus emblica* L.

A small, attractive tree, native to India and adjacent countries to the east, with light-green to bluish foliage, and small, green, acid fruits that are said to make very good preserves. Succeeds best at elevations above 300 meters.

Ngoñgot, P. See Coconut.
Niog, B., Ib., Il., T., V. See Coconut.
Niog-ñga potí, V. See Coconut.
Niog-niogan, T. See Manalú.
Obieng, Il. See Rukam.
Ogób, B. See Gomíhan.
Óloy, T. See Marang.
Oñgot, Z. See Coconut.

ORANGE. *Citrus aurantium* L.

A more or less thorny, small to medium-sized tree with compact crown, attaining a height of 7.5 to 12 meters, native of China or Indo-China. The fruit is roundish, greenish to orange yellow, subacid, juicy, refreshing and of good flavor and quality. The orange is well distributed but the quality of the fruit of the native trees is usually poor. The following standard varieties have been introduced: Bahia, Bessie, Boone, Brown, Carleton, Centennial, Dugat, Duroi, Enterprise, Everbearing, Excelsior, Foster, Holdfast, Homosassa, Jaffa, Joppa, Larrantta, Magnum bonum, Majorca, Malta blood, Maltese oval, Mediterranean, Nonpareil, Paperind, Pineapple, Ruby, Tardiff, St. Jago, St. Michael's blood, Navelencia, Valencia, Vini, Vinous, White siletta.

Ovas. See Grape.
Pa-a, Ib. See Breadfruit.
Paacac, Ib., Il. See Breadfruit.
Pabangui. See Antol.
Pacancál, P. See Alacáo.
Paga, Mt. Palanau.
Pagpagan, Il. See Kabiki.
Paguinga, Ib. See Bignay.

†PAHO, T., V. *Mangifera altissima* Blanco.

A large, very attractive tree, 15 or more meters high, of more upright habit than the mango, and with larger leaves, of wide distribution. The fruit is 5 to 8 centimeters long, and 4 to 6

centimeters in cross section, shaped like the mango, smooth, green to yellowish, resinous, used for pickling throughout the Archipelago. Not cultivated.

Pahohótan, T., V. See Juani.

Pahuhutan, T. See Paho.

Pahutan, T. (There is also a variety of the mango under this name which is quite distinct from the paho.) See Paho.

Pálacpálac, T. See Alacáo.

Palalacanin, T. See Calapi.

†**PALALI**, B., Ib., Il., Mt. *Dillenia riefferscheidia* F. Vill.

A very ornamental tree of medium to large size, with large, dark-green leaves; from northern Luzon to Mindanao, at low and medium altitudes. The fruit is similar to a very large catmon and makes a good preserve. Adapted to humid regions with abundant rainfall well distributed.

The name "Palali" signifies sour, and is also applied to the catmon.

†**PALANAU**, Mt. *Rubus fraxinifolius* Poir.

An ascending bramble, up to 2 meters tall, with reddish canes, of vigorous growth, sparse spines, and 5 to 11-foliate leaves, and of wide distribution in the Philippines, from sea level to an altitude of 2,100 meters. Berries in clusters, 10 to 15 millimeters across, bright red, fairly juicy, edible but lacking in flavor. Very similar pomologically to the ragini and copela.

Palatangan, Il. See Bayante.

Pali, V. See Juani.

Palutan, Ib. See Bitungol.

Pamanmalien, Pa. See Catmon.

Pamocol, T. See Coconut.

Pampáng, V. See Banana.

†**PANGAO**, Mt. *Sterculia oblongata* R. Br.

A semideciduous tree of upright growth attaining a height of 12 meters. The nuts, similar to, but somewhat smaller than the bangár, are contained, 4 to 6, in bright-red pods, and are of good flavor roasted. Of wide distribution. Eaten in some districts of the Mountain Province. Recently domesticated.

Pángas, Z. See Ginger.

†**PANGI**, T., V. *Pangium edule* Reinw.

A large tree, 30 meters tall, of rapid growth and large, bright-green leaves, occurring from southern Luzon through the Visayas and Mindanao. The fruit is large, brown colored and roughish, and contains numerous seeds of the size of a cashew nut, embedded in a sweet, yellowish, edible pulp. The seeds are poisonous, but are rendered edible by steeping in water,

after which they become a palatable food. Very rare in cultivation.

Pangmangaan, Il. See Paho.
Panglongbuyen-copaioba, Il. See Manquil.
Panglumbuyan, Il. See Adang.
Pañgosin, V. See Coconut.
Pangui, V. See Pangi.

*PANIALA. *Flacourtia cataphracta* Roxb.

A thorny, small tree, of compact growth, native of India and adjacent countries to the east, bearing small, oblate, purplish, subacid fruits, 2.3 centimeters in diameter, suitable for preserves.

Panuto, V. See Alpay.
Papagan, Il. See Kabiki.
Papling, T. See Muling.

PAPAYA. *Carica papaya* L.

A large, treelike dioecious or hermaphroditic herb, indigenous to the American Tropics, with large, palmate leaves, of rapid growth, of wide distribution, and commonly cultivated everywhere. The fruit is large, roundish to oblong, greenish to yellowish, with orange-yellow, sweet, juicy and well flavored flesh, forming a central cavity containing the seeds. Partly grown, the boiled fruits make a delicious vegetable.

Parasán, V. See Calapi.

*PARCHA. *Passiflora laurifolia* L.

A climbing, perennial vine of moderately vigorous growth, native of the West Indies. The fruit is roundish oblong, about 5 or more centimeters long, yellowish, smooth, and of an agreeable, acid flavor. Recently introduced.

Pasác, T., Z. See Kabiki.
Pasoso, T. See Manquil.
Patlong, Z. See Muling.

PEACH. *Prunus persica* Sieb. et Zucc.

A small tree, native of China, with a variously shaped fruit, from flattened to roundish or beaked, 5 to exceeding 6 centimeters in diameter in large-fruiting varieties, yellowish to reddish on sun-exposed side, velvety, fleshy, juicy, subacid, and of delicious flavor. Has been successfully fruited in the high altitudes of northern Luzon. Adapted to elevations of and above 1,200 meters.

Pelipeli, B. See Bayante.

PEPPER. *Piper nigrum* L.

A climbing vine, the berries of which are dried and marketed as pepper in the world's trade, native of South India and Ceylon.

Grown to a limited extent in Batangas. The pepper succeeds best in a shady situation in a moist climate, and the plants should be trained to grow on the trunks of small trees for support and shade.

*PERESKIA. *Pereskia aculeata* Mill.

A climbing, spiny vine of rapid growth and fleshy leaves, indigenous to tropical America. The fruit, produced in great profusion, is a round, yellow berry, about 2 centimeters in diameter, with leafy bracts, juicy, mildly acid and rather insipid, but is said to make a good preserve. Recently introduced. Fruited at Lamao for the first time in 1914.

Peris, T. See Antol.

*PHALSA. *Grewia asiatica* L.

A large, spreading, semideciduous shrub, native of India and adjacent countries to the east, with dark-blue, small, sweet, subacid berries of good flavor, containing comparatively large seeds, produced in great profusion. The fruit may be eaten out of hand and is said to make good preserves. Of recent introduction. Fruited for the first time at Lamao in 1914.

*PHYSALIS. *Physalis peruviana* L.

A perennial herb, rarely exceeding 75 centimeters in height, native of South America, bearing inclosed in the bladder-like calyx, a greenish, juicy, fleshy fruit that makes excellent jam. Has given very satisfactory yield at and above an elevation of 1,000 meters, and would probably succeed down to 300 meters. Naturalized in the Mountain Province.

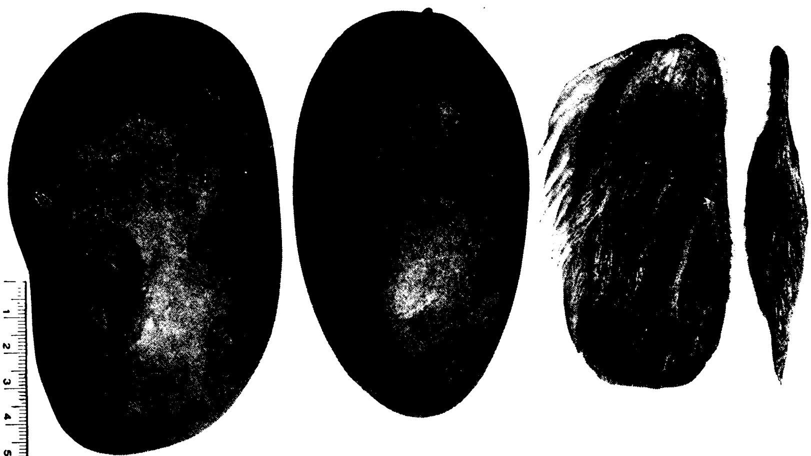
Pias, Il. See Camia.
Piat, Ib. See Carambola.
Picso, Mt. See Citron.
Pilaui, T. See Pili.

†PILAY, Mt. *Rubus niveus* Thunb.

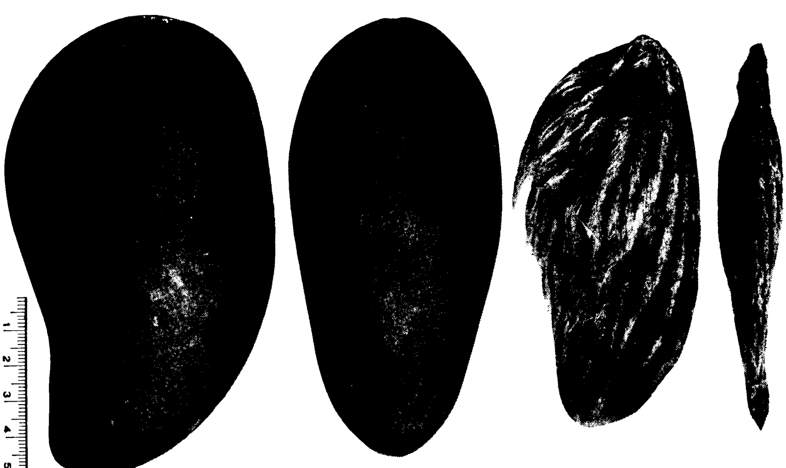
A bramble, found in northern Luzon at elevations ranging between 1,320 to 1,650 meters, with spiny canes up to 2.5 meters long, of vigorous growth, the young growth covered with a white bloom. Leaves 5 to 9 foliolate, white beneath. Fruits in terminal clusters, 1 centimeter across, hemispherical, bluish, subacid and of good flavor. Not cultivated.

†PILI, B., T., V. *Canarium ovatum* Engl.

A medium to large tree, 15 to 25 meters tall, adapted to a moist climate with abundant rainfall reasonably well distributed. The fruit is black, smooth, and shining and contains one seed, the "pili nut," enclosed in a fleshy husk, which is edible when



(*a*) The "carabao" mango.



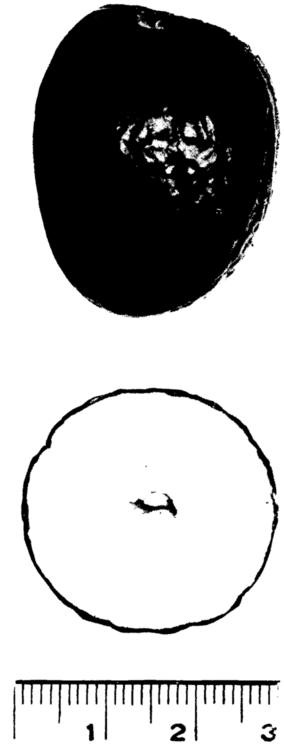
(*b*) The "pico" mango.

PLATE XII.

(*a*) The Feijoa, *Feijoa sellowiana*. Natural size.

Courtesy of Mr. David Fairchild, U. S. Department of Agriculture.

(*b*) Side view and cross section of the fruit of the Brazil nut, *Bertholletia nobilis*, showing the arrangement of the nuts.



(*c*) The Cubili, *Cubilia blancoi*.

cooked. The nuts are oblong, pointed, triangular; the kernel is of excellent quality. Rarely cultivated. While the pili occurs in several other provinces, all the nuts marketed are obtained in Sorsogon, Albay and Ambos Camarines.

Pimiénta, Sp. See Pepper.

PINEAPPLE. *Ananas sativus* Schult.

An herbaceous plant, indigenous to the American Tropics, with long, stiff, usually spiny leaves, arranged in a rosette. The fruit somewhat resembles a very large pine cone, and is sweet, subacid, juicy, and of excellent flavor and quality eaten raw or preserved. Very generally distributed, but grown more for the fiber than the fruit except in Bataan, the only province where pineapple growing has assumed a commercial aspect. Three native varieties are cultivated. Of late years the Abakka, Cabezona, Cayenne, Deliciosa, Eden, Spanish, Sugarloaf, and an unnamed variety from Singapore, have been introduced. (Pl. VIII, *a*.)

Piña, Sp. See Pineapple.

***PINHO.** *Rollinia* sp.

A small tree native of Brazil, bearing small, orange-yellow fruits with sweet pulp. Of recent introduction.

Pinit, Il. (A name used in the generic sense for all species of *Rubus*.)
Piras, V. See Iba.
Pisas, Il. See Camia.
Pison. See Tizon.
Píta, Il.

***PITANGA.** *Eugenia uniflora* L.

A tall, arborescent shrub, up to 6 meters in height, of Brazilian origin. The fruit is roundish, ribbed lengthwise, dark red to black, smooth and shining, juicy, subacid, of very good flavor and contains one rather large seed. Eaten as a dessert fruit. Fruited for the first time at Lamao in 1911.

Plátano, Sp. See Banana.
Pohpoho, Mt. See Citron.
Polon, Mt. See Antol.

POMEGRANATE. *Punica granatum* L.

A medium-sized shrub, indigenous to northern Africa and southern Europe, of rather rare occurrence, best adapted to the dry regions of the Archipelago. The fruit is 7 to 10 centimeters across, roundish, reddish, with a bony "shell," containing the subacid, pinkish, sprightly, "grainy," excellent-flavored flesh, which unfortunately contains too many and too large seeds.

POMELO. *Citrus decumana* L.

A thorny tree, 6 to 12 meters high, indigenous to Malaya and Polynesia. The fruit is large, 10 to 15 centimeters in diameter, roundish to pear-shaped, and contains grayish to more or less red, subacid, juicy, refreshing flesh. Of wider distribution than any other species in the genus but nowhere of commercial importance. Nearly all "native" fruit is of very poor quality. The following varieties have been introduced: Duncan, Ellen, Marsh, McCarthy, Pernambuco, Royal, Siam seedless, Triumph, Walters.

Popowan. See Paho.
Póras, V. See Iba.
Poren, Mt. See Antol.
Potot, V. See Coconut.
Pulapula, M. See Banana.
Puled, Ib. See Muling.
Pupugan, Mt. See Palanau.
Quilinggiva, V. See Camia.
Quingingi, Mt. See Calpi.

†**RAGINI,** B. *Rubus rosaefolius* Sm.

An erect, spiny shrub, rarely exceeding a meter in height, found in many parts of the Archipelago from an altitude of 300 to above 1,000 meters, and also native to India and eastward to China and Japan. Leaves 3 to 7 foliate, glabrous or velvety; fruit in clusters, 16 millimeters across, bright red, quite juicy, but rather insipid with only a trace of acidity and sugar. Not in cultivation in the Philippines.

***RAMBI.** *Baccaurea motleyana* Muell. Arg.

A tree of medium to rather large size, indigenous to Malaysia. The fruits are of about the size of a ciruela, subacid, and well flavored. Eaten as a dessert fruit. Of recent introduction.

RAMBUTAN. *Nephelium lappaceum* L.

An arborescent, large shrub rather than a tree, of Malayan origin, with dark-green, pinnate leaves, adapted to a humid climate with the rainfall well distributed. The reddish fruits, produced in large, loose clusters at the end of the twigs like the mango, are somewhat larger than a ciruela, covered with long, soft spines, and contain a whitish, juicy, subacid pulp of excellent flavor, in which is embedded a rather large seed.

Rattan, edible. See Bejuco.
Remuran, B. See Calapi.
Rima, T. See Breadfruit.

†**ROLFÉIA.** *Rubus rolfei* Vid.

A semiprostrate bramble, with canes 2 to 3 meters long, and trilobate, above dark green, beneath russetted, velvety leaves;

of wide distribution at elevations of about 1,700 meters, from northern Luzon to the Visayas. The berries are yellow, juicy and of excellent flavor, equal to the atíbu. No native name being known the above is proposed as a vernacular name.

***ROSELLE.** *Hibiscus sabdariffa* L.

An herbaceous, spreading annual 1.5 to 3 meters high, native of India, the calyces of which are used in making preserves, jelly, syrup and wine; the leaves may also be utilized in the manufacture of the last three mentioned articles and also boiled and eaten like spinach. The following varieties are being cultivated in all parts of the Archipelago: Archer, Rico, and Victor.

Rucrueso, Ib. See Tulana.

†**RUKAM.** *Flacourtia rukam* Zoll. et M.

A small tree, 6 meters in height, of wide distribution. The small fruits, similar to those of the bitungól, grow 2 to 5 in the axils of the leaves, and are violet colored, fleshy, subacid and of good flavor. Not in cultivation; recently domesticated.

Saba-ti-caag, Mt. See Banauac.
Sacat, T. See Dalinsi.
Sagacat, Mt. See Nanca.
Sâguing, T., V. See Banana.
Salabagin, V. See Rukam.

***SALAK.** *Zalacca edulis* Reinw.

A spiny palm, native of Malaya, said to bear a subacid, well flavored but rather astringent fruit.

Sal-lapugud, Il. See Bayante.
Salomágue, Il. See Tamarind.
Samalágui, V. See Tamarind.
Sambâc, B. See Tamarind.
Sambag, V. See Tamarind.
Sambágui, V. See Tamarind.
Sambalágui, V. See Tamarind.
Sambaldugue, Il. See Cashew.
Sambonalan. See Tulana.
Samílin, T. See Cinnamon.
Samlagui, V. See Tamarind.
Sampalágui, B. See Tamarind.
Sampaloc, B., P., T. See Tamarind.
Sampinit, V. (Employed generically for all species of the genus *Rubus.*)
Sanbag, V. See Tamarind.

SANDIA, Sp. *Citrullus vulgaris* L.

An annual, trailing herb, native of tropical Africa, with large, oblong, variegated fruits and red, juicy flesh, eaten out of hand. A good preserve may be made from the peel. Of very general cultivation but generally of inferior quality.

Sanpongpong, B. See Pangao.

SANTOL, B., P., T., V. *Sandoricum koetjape* Merr.

A medium-sized tree attaining a height of 15 meters, native to India and adjacent countries to the east. The fruit is roundish, flattened, about 5 centimeters long, light-khaki brown, and contains a semitranslucent, juicy, somewhat fibrous, subacid pulp, in some varieties of excellent flavor, in which are embedded five large seeds. Of wide distribution and cultivation.

Santor, Z. See Santol.
Sapinit, T. (Used in the generic sense for all species of *Rubus*.)
Saplugan, M. See Bayante.
Sapote. See Zapote.
Sáua-sáua, V. See Bitungol.

***SEAGRAPE**. *Coccoloba uvifera* L.

A spreading tree, native of tropical America, of small to medium size, 8 or more meters tall. The fruit, produced in long pendant racemes somewhat like those of the bignay but larger, are 15 millimeters across, bluish, subacid and edible. Of recent introduction.

***SERALI**. *Flacourtia ramontchi* l'Herit.

A small shrub or tree, native of India, with a fruit reported to be of about the size of a plum, subacid and suitable for preserves. Recently introduced.

Sico, V. See Chico.
Sindóc, T. See Cinnamon.
Sirihúelas, T. See Ciruela.

***SONCOYA**. *Annona purpurea* Moc. et Sessé.

A small, deciduous tree, of Central American origin, rarely exceeding 6 meters in height. The fruit is described as being three times as large as the custardapple or even larger, roundish, with prominent projections, very aromatic and of excellent flavor and quality. Recently introduced.

Sosong-dalaga, Z. See Muling.

SOUR ORANGE. *Citrus vulgaris* Risso.

A small, thorny tree up to 9 meters in height, indigenous to southeastern Asia. The fruit is somewhat larger than the orange with a rough surface and juicy, acid pulp, and may be used in making ade. Known with certainty only in Mindanao.

***STRAWBERRY**. *Fragraria chiloensis* Duch.

A low, perennnial herb with carmine-red, juicy, subacid fruits of excellent quality, indigenous to South America. Eaten as dessert fruit or preserved. Does not succeed well below an altitude of 800 meters. Grown in Benguet only. (Pl. VIII, *b*.)

SUGARAPPLE. *Annona squamosa* L.

A tall, deciduous shrub, rarely exceeding 5 meters in height, of West Indian origin. The fruit is heartshaped, about 9 centimeters in diameter, green, tuberculate, with white, sweet, juicy pulp of good flavor, containing numerous, dark-brown seeds. Common in Luzon but rather rare in the Visayas (Iloilo excepted) and Mindanao.

Suha or **Sua**, Il., T., V. (Applied in a generic sense to all the Citrus fruits in some provinces, in others applied specifically to the orange or pomelo.)

Sumalágui, V. See Tamarind.

Súsong-calabao, T., V. (A name used in the generic sense for all species of *Uvaria*.)

Susubiic, T. See Muling.

Susumbig, T. See Muling.

Suya, V. See Coconut.

Tabagoc, V. See Muskmelon.

Tábang, T. See Mabolo.

Tabbayog, Mt. See Pomelo.

†**TABÚ.** *Sterculiaceæ.*

Reported to grow on a vine in the mountains of southeastern Palawan. The fruit is of about the size of a small pomelo, smooth, with a thick rind and white, subacid, juicy flesh of refreshing flavor and excellent quality, containing several rather large seeds.

Adapted to districts with abundant rains equally distributed throughout the year.

Taclang anak, T. (A name applied both to the Baniti and Katuri.)

Tagpam. See Barobo.

Talama, Mt. See Cabuyao.

Talalang, Ib. See Cubili.

Talamisan, V. See Tamisan.

Talihoho, V. See Kabiki.

Talimurun, T. See Calapi.

Talipopo, V. See Kabiki.

Talutalu, M. See Barobo.

Tamanjan, V. See Mamata.

TAMARIND. *Tamarindus indica* L.

A handsome, medium to large tree, up to 20 meters in height, native of tropical Asia and Africa, bearing a fleshy pod with very acid, aromatic pulp; excellent for preserves, jelly, and ade. Commonly cultivated everywhere. Sweet-fruited trees are occasionally found.

Tamarindo, Sp. See Tamarind.

†**TAMBIS**, M. *Eugenia aquea* Burm.

A small tree, occurring in Mindanao, bearing topshaped, frequently seedless, edible, but rather tasteless fruits. Not in cultivation. A name also applied to the manquil.

Tambuyog, Mt. See Pomelo.
Tam-is, V. See Coconut.
Tam-isán, V. See Coconut.

†**TAMISAN**, V. *Citrus longispina* Wester.

An arborescent shrub about 5 meters high with long thorns, found in Cebu and Bohol. The fruit is round, 6 centimeters in diameter, with very juicy, mildly acid pulp of good flavor, containing few seeds. May be eaten as a breakfast fruit or used for ade.

Tampai. See Duhát.
Tampói, T., V. See Yambo.
Tampuhíng, T. See Banana.
Tanpul, Ib. See Yambo.
Tapalong, Mt. See Manquil.
Tapaya. See Papaya.
Tapiasín. See Coconut.
Tarnáte, V. See Banana.
Tatlang-anac, T. See Baniti.
Tayabas, T. See Guava.
Tayataya, V. See Dalinsi.

TEA. *Camellia thea* Link.

A shrub or tree up to 9 meters high, with bright-green leaves, the source of the tea of commerce. Native of India to China. Suited to medium and high elevations. Scattered trees occur in the Mountain Province but the plant is of no commercial importance in the Philippines.

†**TEBDAS**, Il. *Calamus mitis* Becc.

A slender, scandent, almost spineless rattan, occurring in the Batanes, north of Luzon. The fruit is white, 8 millimeters or more in diameter and edible. Not cultivated.

Tengé, Mt. See Alemani.

TERSANA. *Eugenia malaccensis* L.

A medium-sized, handsome tree, up to 10 meters in height, native of tropical Asia, with dark-green leaves and dark-red, rather dry and somewhat acid fruit about 3 centimeters across, edible, but of little value. Rather sparsely distributed.

†**TIBAO**, Il. *Rubus elmeri* Focke.

A trailing, spiny plant, with leaves dark green and rough above, and russetted and velvety beneath, found in northern Luzon at an elevation of from 1,320 to 1,550 meters. Berries

solitary, or in small clusters, up to 15 millimeters across, hemispherical, orange yellow, juicy, subacid, and of good flavor. Not in cultivation.

*TIESSA. *Lucuma rivicoa* var. *angustifolia* Mart.

A small, handsome tree with bright-green leaves, indigenous to tropical America. The fruit is very variable, from small and of the shape of a carissa to about the size and shape of a large hen's egg, with yellow, sweet, rich, rather dry pulp, of good flavor, enclosing one or more large seeds. Eaten out of hand. Recently introduced.

Tila, B. See Binucao.
Tilig, Mt. See Alpay.
Tinálong, T. See Banana.
Tipolo, M. See Breadfruit.

†TITAO, Il. *Rubus ellipticus* Sm.

A bramble with ascending, arching canes, rarely exceeding 3 meters in length, densely covered with stiff hairs, having a few long spines and trifoliate leaves, growing in northern Luzon at elevations ranging between 1,100 to 1,650 meters. Berries in large clusters, hemispherical, about 13 millimeters across, orange yellow, juicy, pleasantly acid with a trace of sugar, and would undoubtedly make a good preserve. Not in cultivation.

TIZON. *Citrus nobilis* var. *papillaris* Blanco.

A small, usually spineless tree, attaining a height of 6 meters. Fruit somewhat larger than the orange, loose skinned like the mandarin, juicy, sprightly, sweet, and of good flavor and quality; seeds few. In Batangas and Laguna. Rarely cultivated.

Toangang, Mt. See Adang.
Tocud-langit, T. See Manalú.
Todiang-calabau, T. See Bayante.
Togop. See Gomihan.
Topo, B. See Manalú.
Tsicu, T. See Chico.
Tugao-tugao, V. See Palanau.
Tugatoy, T. See Kabiki.
Tugup, V. See Gomihan.

†TULANA. *Eugenia aherniana* C. B. R.

A shrub or a small, slender tree about 4 meters in height of wide distribution. The fruits grow among the leaves or just below, and are subglobose, 2.5 centimeters in diameter, dark purple, smooth, rather dry and mealy, edible. Not in cultivation.

Tulanan, V. See Tulana.
Tuoy, T. See Adang.
Uámpit. See Wampi.
Uani, V. See Juani.

†**UAY**, B., T., V. *Calamus mollis* Blanco.

A very variable, climbing, more or less spiny rattan of wide distribution, of which the following subspecies are recognized; var. *inermis* Becc., var. *major* Becc., var. *palavanicus* Becc. The fruits are small, about 1 centimeter in diameter, scaly, pale yellow, subacid, edible, and are produced in large clusters. Not in cultivation.

The name "Uay" while used more specifically for the above species is also employed to designate other species of *Calamus*.

Uban-uban, B. See Mamata.

†**ULAYA**, V. *Castanopsis philippensis* Vid.

A tree of medium size, attaining a height of 12 to 15 meters, occurring sparingly in virgin forests in low and medium altitudes in the Visayas and southern Luzon. The fruit grows in racemes or clusters of 3 to 6 or more, and contains an edible, oblong nut up to 15 millimeters long, in flavor resembling the chestnut. Not in cultivation.

There are a number of other species in this genus having edible nuts, but of only little importance as a source of food.

Ulayan, V. See Ulaya.
Uloy, T. See Marang.
Ungo, T. See Connacon.
Uos, B. See Pangao.
Usao, V. See Alpay.

UVARIA. *Uvaria* spp.

The fruits of certain other species not discussed herein are also edible, but are little known, not cultivated, and of no importance as food plants.

***VANILLA.** *Vanilla planifolia* Ans.

A climbing, fleshy orchid that produces the vanilla of commerce, of Mexican origin. It is best adapted to regions with porous, friable soil rich in humus and fairly abundant rainfall well distributed throughout the year, with a dry or semidry period extending from February to June during the fruiting season.

The vanilla is grown under moderate shade, and trained on small trees, such as *Erythrina indica* and *Jatropha curcas*, for support and protection. The flowers must be hand pollinated to insure fruiting and the pods are cured and dried before marketing.

***VILATTI.** *Feronia elephantum* Corr.

A small to medium-sized, thorny tree about 15 meters in

height, of Indian origin. The fruit is round, of about the size of the tamisan. The pulp, rather dry, sweetish and aromatic, contained in a hard shell like the bael, may be used in making a jelly, said to resemble that made from the apple and black currant. Of recent introduction.

*VOAVANGA. *Vangueria madagascariensis* J. F. Gmel.

A large shrub, native of Madagascar, up to 5 meters high, with greenish-yellow, subacid fruits of good flavor, 2 to 3.5 centimeters in diameter. Fruited at Lamao for the first time in 1915.

WAMPI. *Clausena lansium* Skeels.

A small tree, 7 meters tall, with dark-green, pinnate leaves, of Chinese origin. The yellowish fruits, about the size of a small lime, produced in clusters, contain an aromatic, subacid, rather scanty pulp, which may be made into preserves. Rather a variable species.

Watermelon. See Sandia.

YÁMBO, T. *Eugenia jambos* L.

An arborescent, large shrub or small tree up to 10 meters in height, with dark-green leaves and attractive appearance, native of tropical Asia. The fruit is roundish, 3.5 centimeters in diameter, cream colored to pinkish, smooth, sweet, aromatic, and of good flavor, but rather dry. May be eaten raw and is said to be usable to good advantage for flavoring preserves made of other fruits. Rather rare outside of Laguna and Pampanga.

Yambolin. See Yámbo.
Yambósa. See Yámbo.
Yantoc, T., or Yantog. (A name used in the generic sense for all rattans. See Calapi, Litoco, Tebdas and Uay.)
Yantog na puti, Z. See Uay.

*YARUMA. *Cecropia palmata* Willd.

A small dioecious tree of rapid growth and large, palmate leaves, indigenous to tropical America. The fruit develops from 2 to 5 catkins on a stem, and the long, slender fruits, from 15 to 25 centimeters in length and about 18 millimeters across, develop from the catkins, in the axils of the leaves. The ripe fruit is rather watery, but sweet and of good flavor resembling that of a fresh fig, and may be eaten raw or preserved. Of recent introduction. Fruited at Lamao for the first time in 1913.

Yba, T. See Iba.
Yuppa, Ib. See Galó.

ZAPOTE. *Diospyros ebenaster* Retz.

An attractive, dark-green tree of Mexican origin, attaining a height of 13 meters. The fruit is more or less flattened, about 10 centimeters in diameter, smooth, green, and contains a soft, dark-brown, sweet, aromatic pulp, which may be eaten raw, and with lemon or lime juice added is said to make good filling for pastry. One of the rarest fruits in the Philippines.

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Calamus sp. Litóco.
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Canarium moluccana Bl. Bageja.
Canarium ovatum Engl. Pili.
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Carissa carandas L. Caraunda.
Casimiroa edulis LaLl. Casimiroa.
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Castanopsis philippensis Vid. Uláya.
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Ceratonia siliqua L. Carob.
Chrysophyllum cainito L. Caymito.
Chrysophyllum oliviforme Lam. Caimitillo.
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Citrus decumana L. Pomelo.
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Citrus histrix DC. Cabuyao.
Citrus histrix var. *boholensis* Wester. Canci.
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Citrus limonum Risso. Lemon.
Citrus longispina Wester. Tamisan.
Citrus medica L. Citron.
Citrus mitis Blanco. Calamondin.
Citrus nobilis Lour. Mandarin.
Citrus nobilis var. *papillaris* Blanco. Tizon.
Citrus vulgaris Risso. Sour orange.
Citrus webberii Wester. Calpi.
Citrus webberii var. *montana* Wester. Gúyod.
Clausena wampi Oliv. Wampi.
Coccoloba uvifera L. Seagrape.
Coccoloba sp. Corica.
Cocos nucifera L. Coconut.
Coffea abeocuta Cramer. Coffee-Abeocuta.
Coffea arabica L. Coffee-Arabian.
Coffea canephora Pierre. Coffee-Canephora.
Coffea congensis Froehn. Coffee-congo.
Coffea excelsa Cheval. Coffee-Excelsa.
Coffea liberica Hiern. Coffee-Liberian.
Coffea quillou. Coffee-Quillou.
Coffea robusta L. Linden. Coffee-Robusta.

Coffea ugandæ. Coffee-Uganda.
Cubilia blancoi Bl. Cubili.
Cucumis melo L. Muskmelon.
Cynometra cauliflora L. Lamúta.
Cyphomandra betacea Sendt. Cyndra.
Dillenia indica L. Hondapara.
Dillenia megalantha Merr. Bayáni.
Dillenia philippinensis Rolfe. Catmón.
Dillenia reifferscheidia F. Vill. Paláli.
Diospyros discolor Willd. Mabolo.
Diospyros ebenaster Retz. Zapote.
Diospyros kaki L. Kaki.
Diplodiscus paniculatus Turcz. Baróbo.
Durio zibethinus L. Durian.
Eleocarpus calomala Merr. Connácon.
Eriobotrya japonica Lindl. Loquat.
Eugenia aherniana C. B. R. Tulána.
Eugenia aquea Burm. Támbis.
Eugenia brasilensis Lam. Grumichama.
Eugenia calubcub C. B. R. Adang.
Eugenia curranii C. B. R. Lipote.
Eugenia edulis. Argena.
Eugenia jambos L. Yambo.
Eugenia jambolana Lam. Duhat.
Eugenia javanica L. Macopa.
Eugenia malaccensis L. Tersana.
Eugenia mananquil Blanco. Manquíl.
Eugenia polycephaloides C. B. R. Maigang.
Eugenia sp. Balaúsan.
Eugenia sp. Balúbat.
Eugenia spp. Eugenia.
Eugenia uniflora L. Pitanga.
Eugenia xanthophylla C. B. R. Lapini.
Euphoria cinerea Radkl. Alpay.
Euphoria longana Lam. Longan.
Feijoa sellowiana Berg. Feijoa.
Feronia elephantum Corr. Vilatti.
Ficus carica L. Fig.
Flacourtia cataphracta Roxb. Paniála.
Flacourtia inermis Roxb. Louvi.
Flacourtia ramontchi l'Her. Serâli.
Flacourtia rukam Zoll. et. M. Rukam.
Flacourtia sepiaria Roxb. Bitungól.
Fragraria chiloensis Duch. Strawberry.
Garcinia binucao Choicy. Binucao.
Garcinia dulcis Kurz. Baníti.
Garcinia mangostana L. Mangosteen.
Garcinia rubra Merr. Camani.
Garcinia spp. Garcinia.
Garcinia venulosa Choisy. Katúri.
Garcinia vidallii Merr. Antol.
Genipa americana L. Genipa.
Gnetum gnemon L. Banago.

Gnetum latifolium Bl. Cóliat.
Grewia asiatica L. Phalsa.
Grewia edulis Merr. Balúco.
Grewia stylocarpa Warb. Múling.
Hibiscus sabdariffa L. Roselle.
Ilex paraguariensis St. Hil. Maté.
Inocarpus edulis Forst. Kayam.
Lansium domesticum Jack. Lanzón.
Lansium domesticum Jack. var. *duku.* Duku.
Lansium dubium Merr. Mamáta.
Litchi chinensis Sonn. Litchi.
Lucuma mammosa Gaertn. Chico-mamey.
Lucuma rivicoa var. *angustifolia* Mart. Tiessa.
Macadamia ternifolia Muell. Damia.
Malpighia glabra L. Malpi.
Mammea americana L. Mamey.
Mangifera altissima Blanco. Paho.
Mangifera caesia Jack. Binjai.
Mangifera foetida Lour. Bachang.
Mangifera indica L. Mango.
Mangifera odorata Griff. Juani.
Mangifera verticillata C. B. R. Baúno.
Mimusops elengi L. Kabíki.
Monstera deliciosa Liebm. Cériman.
Morus alba L. Mulberry.
Musa paradisiaca L. Banana.
Nephelium lappaceum L. Rambután.
Nephelium malaiense Griff. Kuching.
Nephelium mutabile Bl. Bulala.
Palaquium philippense C. B. R. Alacao.
Pangium edule Reinw. Pángi.
Passiflora edulis Sims. Lilikoi.
Passiflora laurifolia L. Parcha.
Passiflora quadrangularis L. Granadilla.
Pereskia aculeata Mill. Pereskia.
Persea americana Mill. Avocado.
Phoenix dactylifera L. Date.
Phyllanthus emblica L. Nelli.
Physalis peruviana L. Physalis.
Piper nigrum L. Pepper.
Pitchecolobium dulce Benth. Camanchíle.
Prunus persica Sieb. et Zucc. Peach.
Psidium cattleianum Sabine. Cattley.
Psidium friedrichsthalianum Ndz. Cos.
Psidium guajava L. Guava.
Psidium guineense Sw. Aracá.
Psidium laurifolium Berg. Lauriva.
Psidium molle Bertol. Guisaro.
Punica granatum L. Pomegranate.
Pyrus malus L. Apple.
Rheedia edulis Planch. et Triana. Bérba.
Rollinia emarginata Schlecht. Mirim.
Rollinia orthopetala A. DC. Biriba.

Rollinia sp. Pinho.
Rubus copelandii Merr. Copela.
Rubus ellipticus Sm. Titáo.
Rubus elmeri Focke. Tibáo.
Rubus fraxinifolius Poir. Palanáu.
Rubus moluccanus L. Kinúbo.
Rubus niveus Thunb. Pílay.
Rubus pectinellus Max. Atíbu.
Rubus rolfei Vid. Rolféia.
Rubus rosaefolius Sm. Ragíni.
Sandoricum koetjape Merr. Santól.
Sandoricum radiatum King. Kechapi.
Sapindaceæ. Agláño.
Sarcocephalus esculentus Afzel. Céfalus.
Saurauia bontocensis Merr. Dúguay.
Semecarpus cuneiformis Blanco. Camíring.
Semecarpus gigantifolia F. Vill. Manalú.
Sideroxylon mastichodendron Jacq. Mastic.
Spondias cythereæ Sonn. Hevi.
Spondias lutea L. Mombin.
Spondias pinnata Kurz. Lanno.
Spondias purpurea L. Ciruela.
Sterculia foetida L. Bangár.
Sterculia oblongata R. Br. Pangáo.
Sterculiaceæ. Tabú.
Tamarindus indica L. Tamarind.
Terminalia edulis Blanco. Dalinsi.
Tetrastigma harmandii Planch. Ayo.
Theobroma cacao L. Cacao.
Triphasia trifolia P. Wils. Limoncíto.
Uvaria rufa Bl. Banáuac.
Uvaria sorsogonensis Presl. Alága.
Vaccinium villarii Vid. Alemani.
Vaccinium whitfordii Merr. Cotmo.
Vangueria madagascariensis J. F. Gmel. Voavanga.
Vanilla planifolia Ans. Vanilla.
Vitis rotundifolia Michx. Grape-muscadine.
Vitis vinifera L. Grape-vinifera.
Zalacca edulis Reinw. Salak.
Zingiber officinale L. Ginger.
Zizyphus jujuba L. Jujube.

CURRENT NOTES—THIRD QUARTER.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao Experiment Station.

PROGRESS IN VEGETATIVE PROPAGATION OF TROPICAL FRUITS.

As noted in a previous issue, experimentation in vegetative methods of propagation of tropical fruits is one of the prominent features of the work at the Lamao experiment station, the results of which have been published in the Review from time to time. During the dry season just closed, experiments were conducted with the following species which, so far as known, were shield budded for the first time: Icaco, *Chrysobalanus icaco;* longan, *Euphoria longana;* alpay, *Euphoria cinerea;* rambutan, *Nephelium lappaceum;* bulala, *Nephelium mutabile:* wampi, *Clausena lansium;* alacao, *Palaquium philippense;* mombin, *Spondias lutea;* pangi, *Pangium edule;* lipote, *Eugenia curranii;* guisaro, *Psidium molle;* litchi, *Litchi chinensis;* akee, *Blighia sapida;* and cubili, *cubilia blancoi.*

It has been demonstrated that the cattley guava, cinnamon and annatto may be shield budded, but the results obtained do not as yet warrant publication. Experiments in budding the manquil, *Eugenia javanica,* tiessa, *Lucuma rivicoa* var. *angustifolia,* the mastic, *Sideroxylon mastichodendron,* the caymito, *chrysophyllum cainito,* chico, *Achras sapota,* and chico mamey, *Lucuma mammosa,* have so far failed.

The soncoya, *Annona purpurea,* has been sucessfully budded on the custardapple, *A. recticulata,* and soursop, *A. muricata,* but failed on the sugarapple, *A. squamosa.* The anigli, *Annona senegalensis,* has been sucessfully budded on the custardapple, soursop, sugarapple and mamon, *A. glabra,* the buds so far making a good growth (three to four months after insertion of the bud). According to McMillan, the cefalus, *Sarcocephalus esculentus,* is readily propagated from hardwood cuttings; this has been verified at Lamao during the past season.

Brief directions for the propagation of the above-mentioned species follow.[1]

ALPAY, *Euphoria cinerea.*—Use nonpetioled, light-brown to greenish becoming rough, mature budwood; cut the bud 4 centimeters long; age of stock at point of insertion of bud unimportant.

[1] For a description of the terms petioled and nonpetioled budwood, see this REVIEW Vol. VIII (1915), No. 2, page 135.

BULALA, *Nephelium mutabile*.—Use nonpetioled, russet-colored and somewhat rough, mature budwood; cut the bud 4 to 5.5 centimeters long; age of stock at point of insertion of bud unimportant.

WAMPI, *Clausena lansium*.—Use barely mature, petioled budwood; cut the bud 4 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

GUISARO, *Psidium molle*.—Use nonpetioled, mature, gray to brownish budwood; cut the bud 3 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

ICACO, *Chrysobalanus icaco*.—Use petioled, fairly mature, greenish-brown budwood with lenticels well developed; cut the bud 3 to 3.5 centimeters long; age of stock at point of insertion of bud unimportant.

LIPOTE, *Eugenia curranii*.—Use nonpetioled, turning brown and rough, mature budwood; cut the bud 4 centimeters long; age of stock at point of insertion of bud unimportant.

LITCHI, *Litchi chinensis*.—Use nonpetioled, brown-gray, mature budwood; cut the bud 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

RAMBUTAN, *Nephelium lappaceum*.—Use nonpetioled, brown-gray, mature budwood; cut the bud 4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

PANGI, *Pangium edule*.—Use slender, fairly mature, turning from bright-green to bronze-green, nonpetioled budwood; cut the buds 4.5 to 5.5 centimeters long; age of stock at point of insertion of bud unimportant.

AKEE, *Blighia sapida*.—Use nonpetioled metallic blue-gray, mature budwood; cut the bud 4.5 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

CUBILI, *Cubilia blancoi*.—Use nonpetioled, green and smooth to turning brown and rough, slender, fairly mature budwood; cut the buds 4 to 5.5 centimeters long; age of stock at point of insertion of bud unimportant.

LONGAN, *Euphoria longana*.—Use nonpetioled, bluish-green to turning brown, mature budwood; cut the bud 4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

ANIGLI, *Annona senegalensis*.—Use nonpetioled, well matured budwood from which the green color has disappeared; cut the buds 4 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

CEFALUS, *Sarcocephalus esculentus*.—Make hardwood cuttings of well matured growths 25 to 30 centimeters long and insert from two-thirds to three-fourths their length in sandy soil during the dry season.

ALACAO, *Palaquium philippense*.—Use nonpetioled, metallic-blue, mature budwood; cut the bud 4.5 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

MOMBIN, *Spondias lutea*.—Use slender, smooth, glaucous, nonpetioled, mature budwood; cut the bud large, with ample woodshield, 4 to 5 centimeters long; insert the bud in the stock at a point of approximately the same age and appearance as the scion. Inclined to "bleed" badly.

IS ARTIFICIAL DRYING OF THE BLIGHT-RESISTANT COFFEES ABSOLUTELY NECESSARY.

As stated in the article "Notes on Coffee in Java" published in Volume IX, No. 2, of this REVIEW, the principal difference between Arabian coffee and the various blight-resistant coffees

such as the Robusta, Excelsa, Canephora, Quillou, etc., including the hybrids, so far as it affects the methods of preparation of marketable coffee, is that the Arabian coffee has a loose silver skin that peels off readily after drying no matter by what method. On the other hand, the new, blight-resistant coffees, mentioned above, require rapid drying in houses specially constructed for the purpose, in order to make possible the removal of the silver skin by the hullers and cleaners now in vogue. It will be remembered that the cost of these coffee driers forms the largest single item of expenditure in the installation of a coffee-reduction plant, which, together with the extra expense of artificial drying, increases the cost of production of the blight-resistant coffees above that of Arabian. The elimination of drying houses would therefore undoubtedly be welcomed by the large estates in the Dutch East Indies engaged in growing these coffees even though it would perhaps not be a matter of great moment to these estates, which usually possess ample capital. In the Philippines, however, the situation presents a different aspect. Here the coffee is grown almost exclusively on limited areas by the small farmer who lacks the capital for the construction of driers, and who, unless Government or municipal driers were erected, could not produce from the new coffee species a markettable coffee in competition with Java. The elimination of the expensive drying house is thus here almost vital to the successful introduction of the new coffees among the small growers, and considerable thought has been devoted by the writer to the problem of reducing the cost of artificial drying, or the posibilities of eliminating this process altogether. When the high degree of perfection attained in the machinery for the shredding of cereals and in the cleaning and polishing of rice and various fruits is taken into consideration, there should really not be, in these days of mechanical invention, any insurmountable difficulty in devising an apparatus that would also remove the silver skin of the new coffees. Judging from the price of other similar machinery it would seem that the cost of an attachment to the coffee huller for the removal of the silver skin should not exceed $500. If this could be done it would mean a saving of $7,500 for a drier on an estate of 350 hectares, less the cost of arrangement for sun drying,[1] and it would of course mean an annual saving of the difference between the cost of natural and artificial drying of coffee. Such a device would place the small coffee producer of the Philippines in a position

[1] See page 13, Vol. IX, No. 2 (1916), of this REVIEW.

more nearly equal to that of the owner of the larger coffee estate, since the purchase of such a machine by the growers in community should present no serious obstacle, or it might even be purchased by the municipality and rented out to the growers at a low price.

This need of a "silver skinner" for the new blight-resistant coffees should be a matter of interest to the manufacturers of coffee machinery and inventors.

NOTABLE PLANT IMMIGRANTS.

As noted in a previous issue of this REVIEW, the Dutch department of agriculture, Java, has devoted considerable time to the breeding of coffee, and Java is probably the only country in the world where seed of reasonably pure strains of blight-resistant coffee can be obtained in quantity at present.

Last year the Secretary of the Interior of the Government of the Philippine Islands ordered from Dr. P. J. S. Cramer, chief, plant breeding station, department of agriculture, Buitenzorg, Java, 75 kilograms of seed coffee, which subsequently was brought from Java to the Philippines by the writer. This seed was obtained from the best coffee strains growing at the coffee experiment station in Bangelan, Java, including four kinds of Robusta, two of the Canephora, one of Quillou, two of Uganda, one of Congo and one of Excelsa coffee.

Among many others, seeds and plants of the following species were presented by the Department of Agriculture, Buitenzorg, Java: The duku, *Lansium domesticum* var. *duku;* aracá, *Psidium guineense;* lamúta, *Cynometra cauliflora;* burung, *Baccaurea dulcis;* marón, *Annona montana;* rukam, *Flacourtia rukam;* kanari, *Canarium commune;* and bageja, *C. moluccana.*

Dr. I. H. Burkhill, director of the botanic garden in Singapore, donated to the Bureau of Agriculture a very large collection of tropical fruit trees among which are the following species: Lemása, *Artocarpus polyphoema;* kledang, *Artocarpus lancaefolia;* kabiki, *Mimusops elengi;* kundangan, *Bouea macrophylla; Artocarpus rigida;* kechapi, *Sandoricum radiatum;* kuching, *Nephelium malaiense;* binjai, *Mangifera caesia;* and bachang, *Mangifera foetida.*

The above-mentioned species have all been incorporated in the fruit collection at the Lamao experiment station.[1]

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[1] See this REVIEW, Vol. VIII, No. 2 (1915), p. 69.

MULCH.

"Mulch" and "cover crops" are among the more recent terms in tropical agriculture, and while their use is extending, their beneficial effects upon the crops in connection with which they are employed, and in the maintenance and conservation of soil fertility, are not sufficiently appreciated.

By mulch is understood weeds, grass, leaves, or, in fact, any vegetable growth that is cut and left on the land between the trees in the plantation or orchard. The object in mulching is to diminish or prevent evaporation of water from the soil, to prevent the earth from baking, and to keep the soil cool about the surface. A "soil mulch" is created by stirring the surface soil by repeated shallow harrowings. Cover crops are sometimes referred to as "live mulch." They also serve to improve the fertility of the soil and to prevent erosion on sloping land. When the mulch decays the resulting humus adds to the fertility of the land, and as it is being incorporated therewith it improves the physical condition of the soil.

It is better practice to have the land overgrown with weeds that are not dangerous than to leave it bare of vegetation.

The annual cover crop is commonly planted at the advent of the rains and plowed under, or used as mulch during the dry season. Where perennial, upright legumes are used as cover crops they are mowed down to the ground from time to time before they come into bloom, and the cut vegetation left to decay while the stubble makes a new growth. If woody plants, such as malaganit, *Leucaena glauca,* and madre de cacao, *Gliricidia maculata,* are used as cover crops the growth should not be allowed to exceed a height of over 1.25 meters at the time of cutting, or a slow decay of the stems takes place. In considering the utility of a plant as a cover crop the value of a plant for cover crop purposes depends upon (*a*) the amount of vegetable matter produced, (*b*) nitrogen content contained therein, (*c*) the rapidity with which this decays and becomes incorporated in the soil, (*d*) the habit of growth of the plant (whether or not it climbs the trees and requires frequent cutting back) and ability to cover the ground and choke out weeds, (*e*) if an annual the availability of seeds, and (*f*) its germinative powers.

The character of the cover crop in question should be considered in relation to the permanent crop. In a young hevea rubber plantation, for instance, where the trees are set 6 or

more meters apart, a climbing and twining perennial like the patani, *Phaseolus lunatus,* may be used to great advantage, since it is of very vigorous growth, chokes out even such perennial weeds as the cogon, *Imperata cylindrica,* forms a thick blanket of growth, and does not require annual replanting or cutting. With the trees so far apart there is comparatively little trouble in keeping the plants from climbing the trees.

In the more closely planted coffee and cacao plantation the patani will rapidly make itself a costly nuisance by climbing the trees as compared with upright growing legumes, such as various species of *Tephrosia, Indigofera, Clitoria ternatifolia,* etc., which may be cut repeatedly, but which do not climb the trees, and here are therefore to be preferred to the patani.

In a young fruit orchard, where the trees are planted 7 or more meters apart, annual, quick-growing legumes which form a good growth during the rainy season are more desirable. At its close they may be cut and piled around the trees for mulch and the land planted to corn or some other seasonable crop during the dry season. If this is not desired patani is here also the logical cover crop.

PROFITS IN PAPAYA CULTURE.

In Volume VIII, No. 3 (p. 236), of this REVIEW, the writer called attention to the profits in cultivating the papaya for the collection of the papain, the Hawaii experiment station reporting that papain to the value of $2 can be obtained from one plant, and produced at a profit of more than $5 per kilo. Planted at a maximum distance of 4 meters apart one hectare would contain 625 papaya trees with a yield, according to the above figures, of $1,250, extending over approximately two years.

The following is quoted from the Agricultural News, Barbados:

PAPAIN FROM MONTSERRAT.

The amount of papain exported in 1914 was 2,443 pounds, valued at £1,269. Prices continue to remain steady, and a very considerable stimulus has been given to the planting of papayas as a result of a recent visit of Mr. J. H. Cummings, of a firm of manufacturing chemists of Toronto, Canada, which firm is anxious to handle larger quantities of the article. Several estate owners have become interested, and the extent of the area now being planted in papayas ought to appreciably affect the export of papain in the course of a year or two.

Considering how well the papaya flourishes in these Islands, it seems that it would pay the Philippine planters to look into this matter.

PLANT BREEDING NOTES.

In the science of fruit growing, the Temperate Zone has so outdistanced the Tropics that it seems difficult to "catch up." It is, therefore, somewhat of a consolation to read in the Journal of Heredity that in the United States, at least, the art of budding and grafting the walnut has but recently been mastered. As a matter of fact, the walnut had been propagated by these methods for several generations in Grenoble, France, but the detail requirements of the operations were not known elsewhere, and even less than five years ago, according to Mr. J. R. Smith, the author of the article under discussion, it was reported in the United States that the walnut could not be budded or grafted.

The large range of variation of the walnut is considered both by Mr. Smith, and by Mr. L. D. Batchelor in another article in the same publication, and attention is called to the revolution in walnut growing caused by the application of vegetative methods of propagation to this nut. So rapid has the change been, in fact, that whereas a few years ago all trees planted were seedlings, at present there are few seedling walnut trees offered for sale by the progressive nurseries of California.

With a class of fruit growers so ready to take instant advantage of newly discovered, improved methods in their profession, it is no wonder that California is one of the leading countries in the world in fruit production.

The article by Mr. A. D. Shamel in the same publication on "Bud Variation" is of great interest, and serves to emphazise the necessity of care in the selection of scions for graftage in the propagation of not only citrus fruits but fruits of any other species.

Mr. Shamel states that he found no less than 25 per cent of "drone trees" in some of the best orange groves in southern California, and that the elimination of these trees and the substitution of trees with the average bearing capacity of the remaining trees would have increased the income per acre (0.4 hectare) to the extent of $100. In certain instances the unproductive trees reached the high percentage of 70.

In short, the result of Mr. Shamel's investigations is that it is not sufficient to establish a variety through vegetative propagation. As the number of trees of a variety are multiplied there is a tendency to variation in the quality of the fruit and the productivity of the individual trees. Therefore in order to maintain or raise the standard of excellence of a variety, scions

should always be taken from those trees whose performance record is most satisfactory.

ANOTHER CEREAL FOR THE PHILIPPINES.

The two leading cereals in the Tropics are of course rice and corn. On the other hand, while of perhaps equally wide geographical distribution, the adlay, *Coix lachryma-jobi* L., better known in English under the fanciful name of "Jobs tears," stands at the foot of the list of all the cereals in total production, notwithstanding a protein content approaching that of some of the cultivated legumes and a greater proportion of carbohydrates than most other grains.

The adlay would appear to have been known already to Pliny, and its cultivation as a grain extends through India, Burma, Indo-China, to China and Japan, and through part of Malaysia. In the Philippines the adlay is probably of prehistoric introduction and is but seldom grown as an agronomical crop.

The adlay is a rather coarse annual, and for agricultural purposes should be grown like wheat or barley. The grain of the cereal forms may be hulled and parched or boiled like rice, and milled and baked into bread or otherwise used like wheat flour.

ADDITIONAL NOTES ON CITRUS CANKER.

Since the publication of the note on citrus canker in the last issue of the REVIEW, during the exploration trip recently made to the Mountain Province, the writer made a special effort to ascertain the prevalence of citrus canker in the localities visited and the amount of damage caused by the disease.

Canker was found on *Citrus decumana, C. medica* var., *C. limetta* and its var. *aromatica,* and *C. webberii,* in one or another of the following localities: Lepanto subprovince, Cervantes; and in Kalinga subprovince, Dauangan, Bunhian, Lunas, Tiing, Natonin, Damag and Kaltiang, Lubuagan, and Naneng.

The worst cases of the canker appeared on *C. limetta* and its var. *aromatica.* In a few instances the foliage of the pomelo was quite seriously injured and cankered fruit was found on a tree in Damag. These were rare exceptions however, and the presence of canker on other species of *Citrus* in a municipality was frequently recorded while the pomelo trees were not affected with the disease. In many municipalities no trace of canker was seen, though it may have been present, since lack of time prevented an examination of all trees.

Considering the isolation of all points beyond Bontoc, the

occurrence in the Mountain Province of the citrus canker goes far to substantiate the belief that the disease was present there synchronously with its appearance in Lamao in 1912, and the probability is that it was introduced there many years previous to that time.

Just when the citrus canker gained a foothold in the Philippines will probably never be definitely settled. The fact remains that the disease is widely distributed, though it does not appear to seriously injure the cultivated citrus fruits. The most important of these, the mandarin, is practically immune, as well as its close congener the tizon, also a fruit of unusual merit. The calpi, *Citrus webberii,* very common in the western part of Nueva Vizcaya where it is the most important lemonade fruit, appeared unaffected by the canker.

To one familiar with conditions in the Archipelago the eradication of the citrus canker or its control by disinfectants does not appear to be practicable here, nor, were it so, would the result justify the cost, considering the quality of the Philippine citrus fruits and their relative economic importance. It would appear then that the most practicable method of handling the situation is to limit the planting of citrus trees to those varieties and species that are so resistant to the canker as to suffer but little damage from the bacterium. The extensive citrus collection of both native and introduced kinds at the Lamao experiment station offers unique opportunities for such observations, data on which is being accumulated for publication in a future issue of the REVIEW.

Since the publication of the "Notes on the Citrus Canker" in the last number of this periodical a communication from Mr. G. R. Lyman, of the Federal Horticultural Board, Washington, D. C., states that Miss Clara Hasse has found typical bacteria of the citrus canker in the material collected by the writer in Java and Singapore, and on *Aegle glutinosa,* collected in the Philippines, which was referred to in the above-mentioned "Notes."

THE VALUE OF FIELD NOTES ATTACHED TO THE HERBARIUM SHEETS AS AN AID TO STUDY.

Most botanists, perhaps all, who read this will doubtless recall their examination of one herbarium sheet after another in large herbaria, on which the sole written information consisted of the name of the specimen, locality and date of collection, and the name of the collector. Obviously one cannot from such meager

data form a correct conception of the species, the conditions under which it exists, and its economic value, and the descriptions must necessarily be incomplete.

In the course of the preparation of the paper on "The Philippine Food Plants" appearing elsewhere in this REVIEW the writer had occasion to examine the herbarium in the Bureau of Science, Manila, arranged by Mr. E. D. Merrill, botanist of that Bureau, and appreciate the value of field notes attached to the herbarium sheets.

In beginning this herbarium, Mr. Merrill adopted the plan of having the plant collectors fill out a form giving the essential details of the plant of which material was collected, which form was subsequently attached to the herbarium sheet at the time of mounting the specimen. The result is that, after an examination of the material of a species in the herbarium of the Bureau of Science, it is possible, without consultation of books of reference, to form a good estimate of a species and its economic value.

In the course of years the forms used for the purpose stated have naturally undergone several stages of evolution. The following is a reproduction of the blank form now employed by Mr. Merrill:

FLORA OF THE PHILIPPINE ISLANDS. HERBARIUM, BUREAU OF SCIENCE.

Common name .... Dialect ....
Field No. .... Herbarium No. ....
Collector ....
Island or Province ....
Locality ....
Habitat ....
....
Altitude above the sea .... meters
Tree; shrub; bush; vine; herb..
Height of plant.. M.
Diameter, breast high.. Cm.
Flower ....
(Odor, color, etc.)
....
Fruit ....
(Kind, odor, color, etc.)
Special notes ....
....
Economic uses ....
....
Date ....

This form is 15 centimeters long and 8.5 centimeters wide, bound in sets of 100 in cardboard covers and perforated at the

top so that each form on being filled out can easily be torn off and attached to the specimen collected.

The advantage of the system of having herbarium specimens accompanied by field notes such as the above is so obvious that its general adoption by all botanists can not be too highly recommended.

NEW PHILIPPINE FRUITS.

While the more important economic plants in the Archipelago are probably well known, the possibility of the discovery of new useful and ornamental plants still remains one of the charms of the Philippines to the student and investigator.

Under instructions from the Director of Agriculture the writer made a trip through the Mountain Province in northern Luzon in May and June of this year to investigate the agricultural resources and possibilities of that province. Among other data noted, information was obtained during the trip relative to the edibility of the fruit of the following species, hitherto not recorded, so far as the writer is aware, in horticultural literature: litoco, *Calamus* sp.; connácon, *Eleocarpus calomala;* balaúsan, *Eugenia* sp.; copela, *Rubus copelandii;* tibáo, *Rubus elmeri;* Palanau, *Rubus fraxinifolius;* kinúbo, *Rubus moluccanus;* piláy, *Rubus niveus;* atíbu, *Rubus pectinellus;* dúguay, *Saurauia bontocensis;* Pangáo, *Sterculia oblongata;* alemani, *Vaccinium villarii;* and cotmo, *Vaccinium whitfordii.*

Two of these species appear to be as yet undescribed and unnamed botanically. The titáo, *Rubus ellipticus,* also found in India, from which it has been introduced to other parts of the Tropics, does not seem to have been previously recorded in the Philippines from a horticultural point of view. Descriptions of the above species appear elsewhere in this Review.

ERRATUM.

In No. 2, Volume IX, page 152, of this REVIEW, under "Crop Rotation and Irrigation in Java," the latter part of the fourth paragraph should read as follows: "This is followed by sesame which is harvested in August. The land is then planted to rice, which is harvested in January."

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JAN 20 1921

The Philippine Agricultural Review

VOL. IX FOURTH QUARTER, 1916 NO. 4

SPECIAL ARTICLES

RINDERPEST IN SWINE

By William Hutchins Boynton

ANOTHER STIZOLOBIUM FROM THE PHILIPPINES

By F. A. Coffman

DISTRIBUTION OF CITRUS CANKER

By D. B. Mackie

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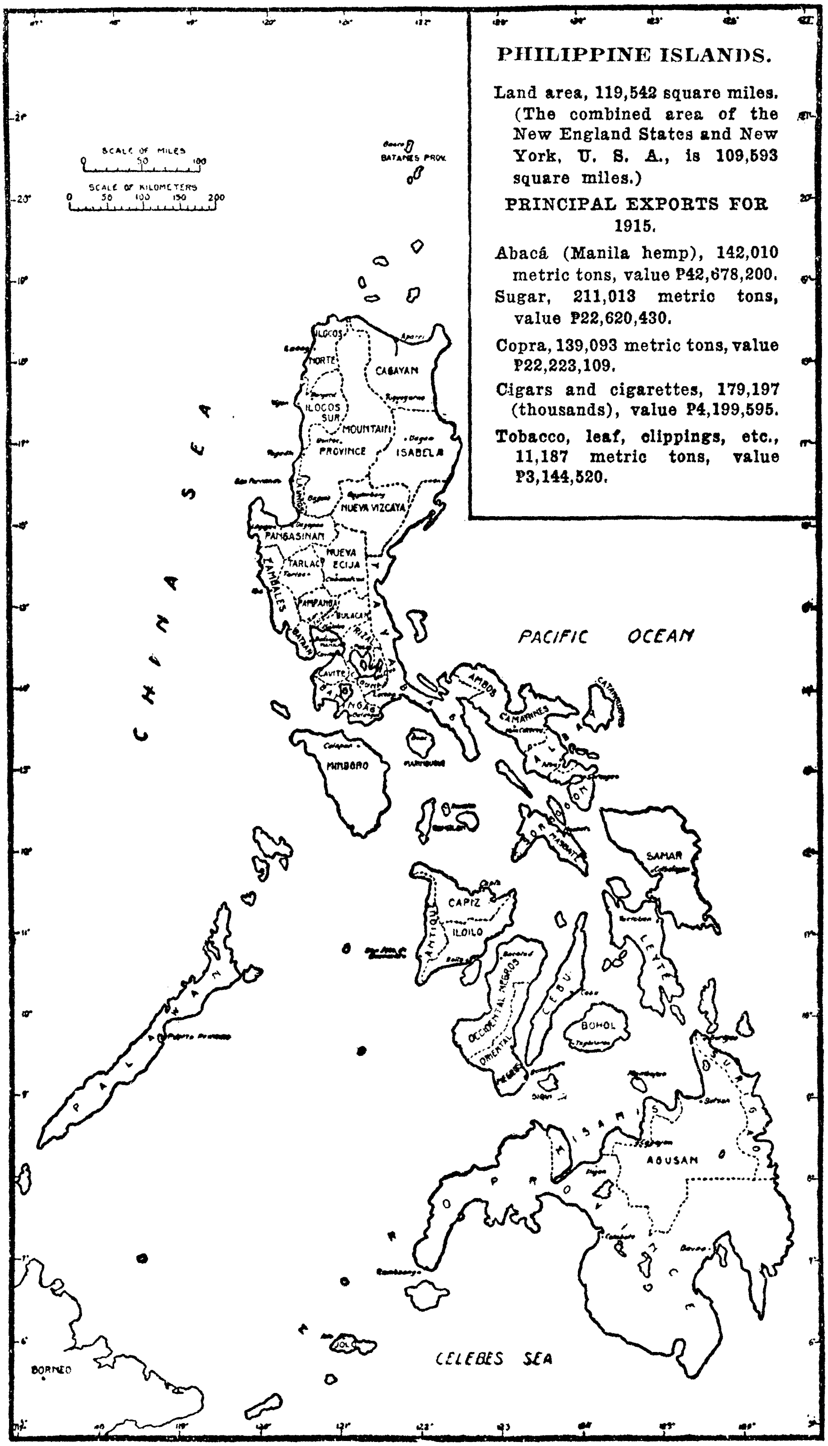
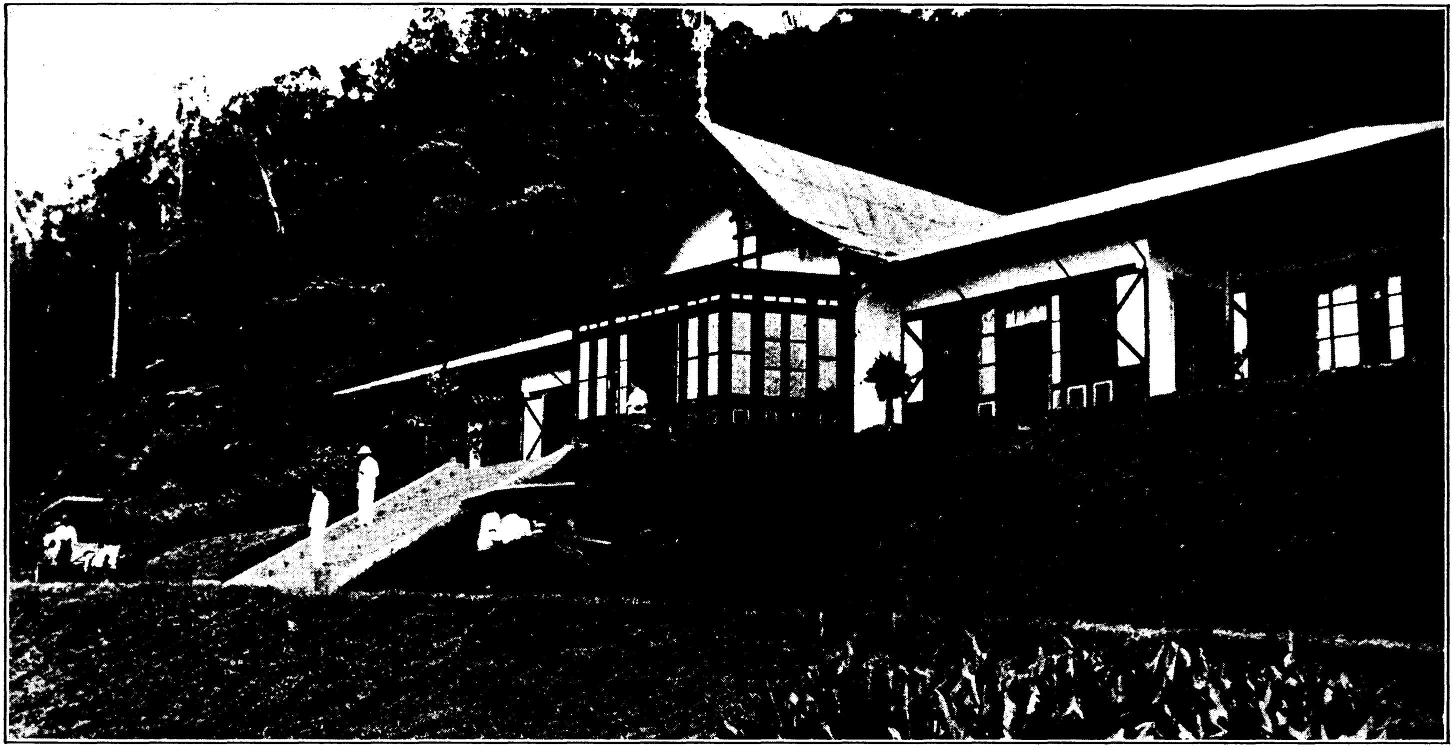

PHILIPPINE ISLANDS.
Land area, 119,542 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1915.
Abacá (Manila hemp), 142,010 metric tons, value ₱42,678,200.
Sugar, 211,013 metric tons, value ₱22,620,430.
Copra, 139,093 metric tons, value ₱22,223,109.
Cigars and cigarettes, 179,197 (thousands), value ₱4,199,595.
Tobacco, leaf, clippings, etc., 11,187 metric tons, value ₱3,144,520.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
TARLAC
NUEVA ECIJA
ZAMBALES
PAMPANGA
BULACAN
BATAAN
RIZAL
CAVITE
BATANGAS
CHINA SEA
PACIFIC OCEAN
AMBOS CAMARINES
MINDORO
SAMAR
CAPIZ
ILOILO
ANTIQUE
LEYTE
OCCIDENTAL NEGROS
ORIENTAL
CEBU
BOHOL
PALAWAN
MISAMIS
SURIGAO
AGUSAN
MORO PROVINCE
CELEBES SEA
BORNEO



Residence of the director of the Gouvernement Kina-Onderneming, Tjinjiroean, Bandoeng, Java.

Courtesy of the Department of Agriculture, Buitenzorg, Java.

UNIV. OF MICH.

THE PHILIPPINE

Agricultural Review

VOL. IX FOURTH QUARTER, 1916 No. 4

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THE RELATION EXISTING BETWEEN THE FARMER AND THE SCIENTIST.

Farming is an occupation which, in all of its principal phases, is dependent upon the practical application of scientific principles. Without the intervention of the scientist little progress would be made in farming.

Practically all cultivated plants have reached their present state of usefulness through conscious or unconscious selection of the better varieties for propagation. Where such selection is made with the definite aim of producing superior plants the progress is rapid and sure, while if this process is left to chance—that is, becomes haphazard—very slow progress or none at all may be expected. Hence, the application of science to the fundamental necessity of agriculture—plants—is necessary if progress or even success is to be expected.

The science of agriculture is simply the systematic practice of rational theory. This is the point in particular which the layman seems not to appreciate.

If theory and practice appear to conflict it is because there is either a flaw in the theory or because it has not been correctly perceived. It has been the constant cry of the farmer that a machine is all very well in theory but when put into actual use is a failure. It is not the machine that is at fault but the theory. Theory must be based on fact. Progress has been the joint work of theory and practices.

The intelligent workman always has a theory or plan upon which his work is based. It is the endeavor of the agricultural scientist to create such an incentive for the farmer.

Lack of scientific education among the cultivators of the soil has been their chief drawback. It has proved the block against which the scientist has stumbled time and again. The farmer has made use of such elementary science as he unconsciously possesses and has reached a point where he no longer makes progress. He stagnates. The farmer who has no comprehension of modern agricultural methods has no place in the march of progress. He stands about the same chance in competition

as the old hand scythe does with the modern mowing machines. The more advanced and the more comprehensive the theory of which the farmer is the master the greater success his efforts attain.

The scope of agricultural science comprehends a vast range of subjects, not only all of the natural sciences, but political and social economy as well. It is in the latter instance that it has proved a boon to the farmer.

The old pioneer farmer selected his crops for the needs of his family and gave little thought to the welfare of his fellow man. The modern agriculturist who produces for the market is bound to consult the demands of his fellow beings. That is why he turns to the scientific agriculturist for assistance, not only in the treatment of his soil, but for the selection of the crops to be grown.

All rural communities have taken on new life in view of the awakened interest in scientific agriculture. It has developed into a system of correct thinking. It has been the mission of the scientist to teach the farmer the underlying reason for the common things he does.

The man who throws aside the knowledge of facts and principles, who does not unite reason, rational theory and practice, loses the elements of success. The farmer who does not base his work on plan or theory finds agriculture a failure.

NOTES ON CINCHONA IN JAVA.[1]

By P. J. WESTER, *Horticulturist in charge of Lamao Experiment Station.*

The virtue of cinchona bark as a febrifuge was first made known in Europe about 1639. This bark, the source of quinine, is obtained from several species of trees of the genus *Cinchona* growing in the highlands of the Andes in South America, and that country supplied an increasing world's demand for the drug during the next two centuries. By then the Dutch in Java, and the English in India, were beginning to realize the value of the plant to those countries provided it could be introduced and grown there, and in consequence attempts were made by the Governments of both those nations to secure cinchona seeds and plants from South America. The cinchona was first successfully introduced into Java about 1850, but the cinchona industry of that island dates from 1865, when *Cinchona calisaya* var. *ledgeriana,* "Ledger," as it is popularly called, was introduced. The culture of the cinchona has since then been solicitously fostered by the Dutch Government and it is an excellent example of what wise paternalism by a government can accomplish in creating new agricultural industries and new sources of revenue.

The cinchona industry in Java is now largely in the hands of private enterprise, but the Government still maintains a large cinchona plantation operated on commercial lines. Research work is of course carried on in conjunction with the commercial operations, and for this the estate has a modern and well equipped laboratory. In addition, there are also attractive, roomy residences for the director (Pl. I, frontispiece) and the superintendent of the plantation, drying houses and storehouses, all electrically lighted and supplied with modern conveniences. This plantation, the "Gouvernement Kina-Onderneming," is located at an altitude of about 1,600 meters in Tjinjiroean, near

[1] Adapted from a report made by the writer in November, 1915, after a visit to Java.

Bandoeng in Preanger, where most of the Javanese cinchona estates are situated.[1]

While its altitudinal range is considerably greater, the cinchona thrives best at an elevation of between 1,400 to 1,700 meters, and with an abundant rainfall equally distributed throughout the year (in Tjinjiroean the annual precipitation averages about 3,000 millimeters). The trees require a light, friable, fertile, well drained soil and the plantations are generally located on the hill and mountain sides which are terraced systematically coincident with the preparation of the land for planting. (Pl. II, a.)

Cinchona calisaya var. *ledgeriana, C. succirubra,* and a hybrid between these two species are most extensively grown for cinchona production.[2] Of these the first-named species is richest in quinine and the one most generally cultivated, but as it also has the defect of being of the weakest growth of the three, it is usually grafted upon the other species, which are of more robust growth and habit but carry a smaller quinine content.

So far no serious diseases or insect pests have appeared in the Javanese cinchona plantations.

The nursery operations begin by clearing the land and grubbing it thoroughly to a depth of 45 to 50 centimeters, removing all stones and roots. The land is then laid off into beds 1.25 to 1.75 meters wide, and twice as long, over which a rainproof, inclined shelter of grass is placed. (Pl. II, *b.*) A small space is reserved in the front part of the shed for the laborer from which he can attend to the seed bed, which occupies the rest of the sheltered space. The seed, which is very fine, is sown thickly, and after watering, the front of the shed is closed so as to leave the seed bed in darkness. The germination of the seed takes place in about a month, and as the plants appear above the ground light is gradually admitted. In the course of five months the seedlings are 3 to 7 centimeters tall, and are then transplanted to other nursery beds, rather less than 1 meter wide and raised 15 to 20 centimeters above the ground, the plants being set out 10 to 15 centimeters apart. When planted in these

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[1] It is a pleasure to the writer to acknowledge his indebtedness to Dr. M. Kerbosch, Director of the "Gouvernement Kina-Onderneming" for the courtesy shown and the information given relative to cinchona during the writer's visit to this institution.

[2] Seeds and grafted plants of cinchona may be purchased by applying to the Director of Gouvernement Kina-Onderneming, Tjinjiroean, Bandoeng, Java.

beds the plants are at first heavily shaded by the use of grass placed on low bamboo frames. As the plants become established this shade is gradually removed, and the plants are grafted when they are a little thicker than a lead pencil.

The grafting operation consists in making a simple side graft about 10 centimeters above the ground, the scion being cut about 75 millimeters long, from fairly mature wood. Bast is used for tying and the wounds are covered with melted wax. The grafting is evidently easily performed, for the work is done by ordinary laborers, both men and women. The plants are set out in the cinchona plantation when from 18 to 24 months old.[1]

The cinchona plantations are all located in a very broken country and the land is therefore always terraced before the plants are set out in the field, the top of the terrace always sloping inward toward the hill in order to prevent erosion. (Pl. III, *a*.)

Partly to catch the surplus rainfall and thus prevent the surface soil from washing away, and partly to aerate the soil, narrow trenches, not more than 15 centimeters wide and about 45 to 60 centimeters deep, are dug in the terraces between the trees, the soil being spread out on the surface of the ground. Leaves and twigs collect in these trenches as the water seeps away and the soil is in this way enriched in plant food. The old trenches are filled and new ones dug once every year. An average of one weeding every six months is considered sufficient to control the weeds in a cinchona plantation.

The young plants are set out about 1 meter apart or sometimes even closer. As soon as they begin crowding each other, the plants are thinned out. The cinchona should be thinned so as to shade the ground enough to protect it against excessive evaporation by the sun's rays, and to assist in keeping down the weeds, but the stand should not be allowed to grow so close as to make the plants spindling for lack of air and light. Beginning with about the fourth year from the date of planting the thinning process proceeds from year to year as the trees grow larger until finally all the plants have been harvested at the age of about 20 years. All sickly trees are dug out and replaced

[1] A small quantity of cinchona seed was received from Dr. Kerbosch by the writer after his return from Java, which was sent to the Bureau of Forestry in Baguio, Mountain Province, for propagation. According to Mr. A. F. Fisher, Acting Director of Forestry, the seed germinated satisfactorily and the plants are making good progress.

by healthy ones. In the course of thinning or harvesting, which are the same thing in a cinchona plantation, the plants are dug out with their entire root system (the bark on the roots being richest in quinine), cut up into suitable lengths so that they can be conveniently handled, and carried to the place where the bark is removed.

This is done mostly by women, who beat the stems, branches, and roots with wooden mallets until the bark is loosened from the wood. Owing to the cool, moist climate, this is accomplished, much more readily than one would suppose, at all times of the year. Bone knives are also used in the course of this work. The bark is then sun dried for a few days until most of the water has evaporated and then dried on shallow trays in hot-air driers called "siroccos." Finally the cinchona bark is ground or beaten to a coarse meal which is packed for export in large bales weighing 100 kilos each.

The first small crop of cinchona bark of about 140 kilos per hectare is obtained four to five years after planting, and this increases gradually until at the age of 10 years the yield attains a figure of more than 1,100 kilos of green bark per hectare, or an average of about 425 kilos of dried cinchona bark with a quinine content of about 6 per cent. At the age of 18 to 20 years the last cinchona trees are usually harvested.

Breeding and selection work with cinchona was begun some thirty years ago by the Dutch Government, since which time grafting has been more or less in practice. It was said, however, that the excellence of the strain in cultivation is due more to the fortunate introduction of a type already rich in quinine, than to the systematic breeding, which so far has but slightly improved the quinine content in the original type. On the other hand the gross yield of cinchona bark per hectare has been increased by continued selection and vegetative propagation, since there is considerable difference in the habit and growth of individual trees which influence the yield of bark.

It is interesting to note that the vigor of the "ledger" decreases in the same ratio as the quinine content increases until the plants richest in quinine have become of such weak growth as to be impracticable for cultivation.

Exhausted cinchona lands are planted to *Lantana camara*, the same cosmopolitan species which flourishes in the Philippines, and which effectually chokes out other more serious weeds. After ten years the exhausted soil is considered to have regained sufficient fertility to be again cleared and planted to cinchona.

According to Dr. J. van Breda de Haan [1] the cinchona bark exports from Java, from a modest 6,000 kilos in 1879, rose to 2,950,000 kilos in 1889 and to 8,175,000 kilos in 1910, when the cinchona exports attained their maximum figure. The fall of prices caused a decrease in production during the succeeding year and in 1914 only 6,940,000 kilos of cinchona bark was exported from Java. The price, which in 1912 dropped to 1.524 cents per ounce, the unit of bark after an agreement in 1915 between the cinchona planters and manufacturers to curtail production and maintain the current value, rose in 1914 to 2.48 cents per ounce, at which price cinchona culture is considered to be very profitable.

In the Philippines, the soil and climate in some parts of southeastern Bontoc, between Talubin, Lias, and to the divide between that municipality and Kadaklan, appears to be favorable for cinchona, and in the other vast agriculturally unexplored regions of the Mountain Province, there may be other districts well adapted to this crop. The United States is one of the world's greatest importers of cinchona bark or its derivatives and its cultivation in one of its own dependencies might therefore be argued. Yet, whether or not it would be adviseable to attempt cinchona cultivation in the Philippines in competition with the well organized cinchona growers of Java remains an open question. That private capital would venture to invest in cinchona culture, an enterprise that requires specialized knowledge, which is altogether experimental so far as the Philippines is concerned, and the use of the product of which is comparatively limited, is extremely improbable. In better position to ignore the financial losses that must necessarily result for many years during the course of such work, the Government might consider the introduction of cinchona into the Archipelago with a view of rendering the United States independent of outside sources for the supply of quinine.

[1] Monthly Bulletin of Agricultural Intelligence and Plant Diseases, Vol. VI, No. 11, p. 1423, 1915.

OBSERVATIONS ON THE DISTRIBUTION OF CITRUS CANKER.[1]

By D. B. MACKIE, *Entomologist.*

Citrus canker is one of the worst, if not the most dangerous, of all the diseases which attack citrus fruit trees.

It has recently made its appearance in parts of the United States, where it has caused more consternation than any other malady which has ever appeared in the citrus-producing districts, and it once threatened to destroy this industry in the State of Florida.

So important is it considered in the United States that the Federal authorities are burning and destroying in the most complete manner possible all citrus trees and groves affected with the disease.

Furthermore, representatives of the Department of Agriculture have visited China, Japan, the Philippine Islands, and other oriental countries to study it and endeavor to ascertain the country of its origin.

At first citrus canker was considered to be of fungous origin, but it is now generally conceded that the disease is bacterial, being ascribed to *Pseudomonas citri* Hasse. It attacks all forms of citrus and seems to be particularly virulent on the species that have become commercially important. (Pl. IV.)

[1] In addition to the field work mentioned in this article, investigations have been carried on by this Bureau for almost a year in an endeavor to develop a practical method of controlling the disease by artificial means.

This phase of the work has been under the supervision of Mr. E. D. Doryland and all the experiments in connection therewith have been originated by him. It is a pleasure to announce that from the results thus far obtained by Mr. Doryland there is every reason to believe that his efforts will be successful.

Justification for this sanguine attitude arises from the fact that a number of badly diseased trees which were treated over seven months ago show no evidence of new infection. The cankers which were present on the twigs now seem to be entirely innocuous as the twigs appear to have recovered their pristine vigor, while the cankers on the leaves have long since died.

While the writer was aware of the existence of such a disease as citrus canker as early as 1914, it was not until June, 1915, at Washington, D. C., that representatives of the Federal Horticultural Board called his attention to the fact that a shipment of budwood sticks, showing infection with canker, had just been received from the Philippine Islands. It would appear that the attention of the Insular Bureau was called to the presence of the disease in the Philippines at about the same time by Mr. Walter T. Swingle of the United States Department of Agriculture, who was then conducting investigations in the Orient with special reference to citrus canker.

With the study of this disease as one of the principal objects of his trip, Dr. H. A. Edson, plant pathologist of the United States Department of Agriculture, came to the Philippines in January, 1916. The writer was detailed to assist Doctor Edson in this work. Beginning with some of the most important citrus districts of the Islands, the investigations were extended to include several of the more remote localities as well.

In Batangas Province a considerable revenue is derived by the inhabitants from the cultivation of a certain variety of *Citrus nobilis* commonly known as "naranjita." Investigations were first made in the vicinity of Lipa. Here the disease was found to be prevalent and also destructive. Pomelos, *C. decumana,* a species so generally favored in the Philippines that one or two trees are planted near almost every house, showed abundant evidence of canker, especially on the leaves, while some cankers were noted on the twigs. Trees of *C. nobilis* also showed signs of infection.

On another occasion, a visit was made to the nursery of the College of Agriculture at Los Baños, Laguna, and here, again, the disease was in evidence.

The first investigations in the more remote districts were made in the vicinity of Catarman on the northeast coast of Samar. Observations in and about the town of Catarman showed the disease to be prevalent on almost all forms of citrus present, being noted particularly on *C. decumana, C. limonum, C. nobilis, C. aurantifolia* and what was evidently *C. micrantha.* The species locally called "dayap," *C. aurantifolia,* apparently showed greater resistance to the disease than any of the others. Outside of the town but one infected tree was found. This was an individual of *C. decumana* located in the immediate vicinity of the boat-landing in the out-lying district of Washington on the Catarman river.

The presence of the disease in Catarman was traced to two

separate shipments of stock received from Manila, one of which was sent to the supervising school teacher some two years previously, while the other went to the Hacienda Catahimican.

The second tour of inspection was made in the Mountain Province. It is an interesting fact that this territory is inhabited chiefly by non-Christian peoples who have just emerged from intestine warfare of many generations duration and have planted practically no citrus stocks other than those which are native to the settlements. Dr. Yates, the mycologist of the Bureau of Science, accompanied Dr. Edson and the writer on this trip. The investigations covered the following territory:

(1) That section of Kalinga which forms a triangle, with the confluence of the Saltan and Chico Rivers as the apex and the two towns of Lubuagan and Balbalan as the base; (2) the Chico River Valley between Bontoc and Tinglayan; (3) the district comprising Bontoc, Talubin, Barleg, Lias, and Ambayaoan; (4) that section of the Chico River Valley, including Bontoc, Alap, and Gunugan; (5) western Ifugao, including the Banaue-Hapao-Hunduan-Kiangan district; (6) that part of Lepanto and Bontoc which includes the towns of Sagada, Besao, Sumadel, Luban, Kayan, Bauco, and Sabangan; (7) that part of Benguet which lies in the Agno River Valley between the towns of Loo and Ambuclao.

It may be interesting to know that prior to 1908 a considerable part of this territory had never been visited by any Christians except a few Constabulary patrols. Within the area covered by this inspection, citrus canker was noted at the following places:

(1) In the jail garden at Bontoc, where several species of citrus received from Manila showed signs of infection; (2) on the plaza in front of the Governor's residence at Lubuagan, where two specimens of *C. decumana* were found to be infected.

It was ascertained that these two trees had been planted in close proximity to Batangas orange stock which was brought from Manila some four years previously by the Governor and which had since died.

Another case of the same species was found at Limus, which is some 25 kilometers from Lubuagan. It was imposible to ascertain the origin of this diseased tree as the natives did not seem to understand the reasons for our questions and were, therefore, suspicious. It was gathered from their conversation, however, that the trees had come from Lubuagan, the stock from there being considered of a superior variety.

During this same period Mr. Zimmer, assistant entomologist

of this Bureau, was conducting investigations relative to this disease in other parts of the Archipelago, his work taking him to the Islands of Cuyo, Culion, Dumaran, Palawan, and Balabac and to the southern part of Mindoro.

In Palawan Mr. Zimmer's work included the territory from Puerto Princesa to Brookes Point and Sarong on the east coast, working north to Canduaga on the west coast, and thence over the mountains to the east coast again. He reports that *C. decumana*, *C. limonum*, and *C. aurantifolia* were noted, but in no case did he discover evidence of canker.

It is unfortunate that Mr. Zimmer was unable to visit the Tagbanua reservation which has been established at Aborlon, and the penal colony at Iwahig, as it is believed that citrus has been received there from Manila which might possibly be infected with canker.

A considerable part of the regions above mentioned are inhabited chiefly by non-Christian peoples who are not acquainted with any citrus other than the varieties found in the districts in which they live and seldom concern themselves regarding the introduction of new species.

It is believed that these investigations in the more remote districts tend to show whether or not citrus canker is indigenous to the Philippines, and the office of pest control of this Bureau is making further investigations in an endeavor to determine the area at present invaded by this disease.

In conclusion, it may be stated that the fact that this disease has not been found in any of the remote districts of the Archipelago leads one to believe that its introduction into the Islands is comparatively recent. This opinion is concurred in by Messrs. Edson and Yates, while Mr. Swingle concludes that citrus canker is not indigenous to the Philippines but he does not express any opinion as to the date of its introduction.

Should further investigation tend to confirm present views, there will be another very pertinent example of the necessity for a more stringent plant quarantine to keep out undesirable plant pests and diseases.

ANOTHER STIZOLOBIUM FROM THE PHILIPPINE ISLANDS.

By F. A. COFFMAN, *Station Superintendent.*

The need of a leguminous cover crop, earlier maturing than the Florida velvet bean, yet not attacked by wilt as is the cowpea, has long been realized by students of southern agricultural questions. For several years the United States Department of Agriculture has been working on this problem, and to this end has introduced and tried out many species of Stizolobium beans. As a result the department has met with considerable success, since the Yokohama bean (*Stizolobium hassjoo*), a recent introduction, has proved a valuable cover crop.

During 1911, Mr. C. V. Piper, who has done considerable work with beans for the Bureau of Plant Industry, introduced into the Philippine Islands several species of Stizolobium, among which was the fleshy-pod bean (*Stizolobium pachylobium*), and about the same time some hybrid seed of the Florida velvet (*Stizolobium deeringianum*) and of the Lyon bean (*Stizolobium niveum*) was received here from Gainsville, Florida.

These seed samples were sent to the Lamao, Alabang, and Singalong experiment stations, for testing. It seems from the records in the Bureau office at Manila that the tests were not very satisfactory and the beans were not planted again, at least to any extent. No records of further tests seem to exist and apparently the beans were forgotten. In December, 1914, the writer discovered two mixtures in the seed from a small plot of Lyon beans grown at the La Carlota experiment station.

One of these mixtures was apparently not a pure type; the seed varied considerably as to size and shape, and ranged from subglobose and smaller than the Florida to as much compressed and larger than the Lyon bean. The marbling of the seed coat varied, some of the beans having a spread type of mottling while others were nearly white. (Pl. VII, *a, b;* VIII, *a.*) The pods differed slightly from the Lyon-bean pods, being a little darker, a little larger, more pubescent, and covered with rather loose, yellowish-

white hairs, were less curved, and the ridges on the valves were not so prominent.

It appeared that these beans were hybrids and since they so closely resemble photographs of some of the beans resulting from investigations of Mr. John Belling, of Florida, in crossing the Lyon and Florida velvet beans, it was believed that these too were the result of a cross between those beans.

The seed of the other mixture were large, much compressed, and mottled with black or brown spots on ash gray. The pods were much larger and darker than the Lyon-bean pods. As no clue to the source of this bean could be found at La Carlota, a plot of 20 seeds was started February 17, 1915.

As the writer anticipated a transfer to Manila, and expected to complete the test elsewhere, little attention was given these plants, though a few general observations were made. A perfect germination was secured, and the plants made a rapid growth. The plants seemed to be all of one type, no variations being noticed. The vines had a purplish pigmentation, especially at the base of the petioles, and the leaves were large, more acute, and not undulate as are those of the Lyon bean. Flower buds were first noticed April 15. The flowers were purple, and the pods were borne in clusters of 4 to 8, a few of 12 to 15 being found. The root nodules were numerous and usually large, some being nearly 3.5 centimeters in diameter. (Pl. VIII, *c*.)

July 19 the vines were noticed to have lost most of their leaves and many of the pods were showing signs of maturity. Mr. Homer C. McNamara, who relieved the writer at La Carlota, reports that insects and larvae, together with extremely wet weather, caused practically all of the pods to rot before they had fully matured. As a result only 36 seeds were secured from the twenty vines, and these from pods picked before fully mature and allowed to finish ripening after being picked.

Upon returning to Manila a careful examination of the records of plant introductions of the Bureau of Agriculture was made. After considerable searching, the writer learned of the introductions by Mr. Piper and of the hybrid bean from the Florida experiment station. Since a small quantity of Lyon-bean seed was sent to La Carlota in May, 1913, which very likely came from Lamao, it is not difficult to believe that the mixtures found at La Carlota came in this seed. The large spotted beans are thought to be progeny of the introduction by Mr. Piper, and the hybrid beans to be either the result of the hybrid seed from Florida, or else the result of a natural cross, since both "velvet" and Lyon beans seem to have been grown at Lamao at the same

time. It appears from the records that these mixtures in the Lyon beans must have passed unrecorded and possibly unnoticed for several years.

It was decided to test the beans at the Singalong station in Manila and on August 4, twenty apparently typical seeds each of the Lyon bean and the two beans found mixed with the Lyon bean were planted. The more important data taken throughout the test are as follows:

PLOT I.—*S. niveum.*

Aug. 4, 1915: Seeds planted.
Aug. 11, 1915: 100 per cent of seeds germinated.
Aug. 20, 1915: Plants started to vine.
Aug. 30, 1915: Vines slightly over 75 centimeters long.
Oct. 1, 1915: Vines 3.37 meters long.
Oct. 15, 1915: Root nodules numerous, but not as large as in plot II.
Nov. 5, 1915: Flowers appeared about this date; white.
Dec. 1, 1915: Vines larger than other two, bearing blossoms and young pods abundantly.
Jan. 27, 1916: Harvested ripe pods, 60 per cent of pods still green. Many flowers and young pods still existed, the ripe pods shelling badly. About 25 per cent of leaves had fallen. Yield of ripe seed less than one kilogram. Another month could not have completely matured the crop of seed. Vines slightly larger than the vines in either of the other plots. Plot plowed up to make room for other work.

PLOT II.—*Hybrid Stizolobium.*

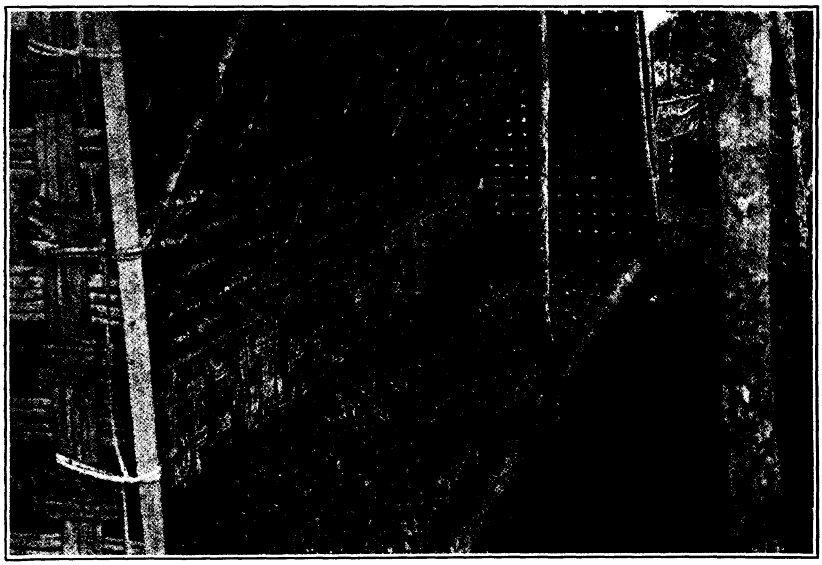
Aug. 4, 1915: Seeds planted.
Aug. 11, 1915: 55 per cent of seeds germinated.
Aug. 25, 1915: Plants started to vine.
Aug. 30, 1915: Vines 75 centimeters long.
Oct. 1, 1915: Vines 4.0 meters long.
Oct. 15, 1915: Root nodules numerous but not as large as in plot III.
Nov. 5, 1915: First flowers appeared about November 5. Differed from plot I in having scattering coarser black hairs on calyx.
Dec. 1, 1915: Vines bore abundance of both blossoms and pods of all sizes; young pods bore a soft yellowish pubescence.
Dec. 15, 1915: Pods began to ripen.
Jan. 27, 1916: Harvested all ripe pods; 30 per cent were not yet ripe. No flowers were seen and the leaves had nearly all dropped off; no seed was lost by shattering; yield of ripe seed slightly more than one kilogram. No apparent mixture. Pods from 4 to 10 per bunch, usually 5 seeds per pod. Plot plowed up to make room for other work.

PLOT III.—*Spotted Stizolobium.*

Aug. 4, 1915: Seeds planted.
Aug. 11, 1915: 80 per cent of seeds germinated.
Aug. 20, 1915: Plants started to vine.
Aug. 30, 1915: Vines 1.15 meters long.

(*a*) Land cleared and terraced preparatory to planting cinchona, Java.

Courtesy of the Department of Agriculture, Buitenzorg, Java.



(*b*) Interior of germinating shed for cinchona. (The upright, portable side of the shed is fastened to the posts seen at the extreme right during the germination of the seed.)

Courtesy of the Department of Agriculture, Buitenzorg, Java.

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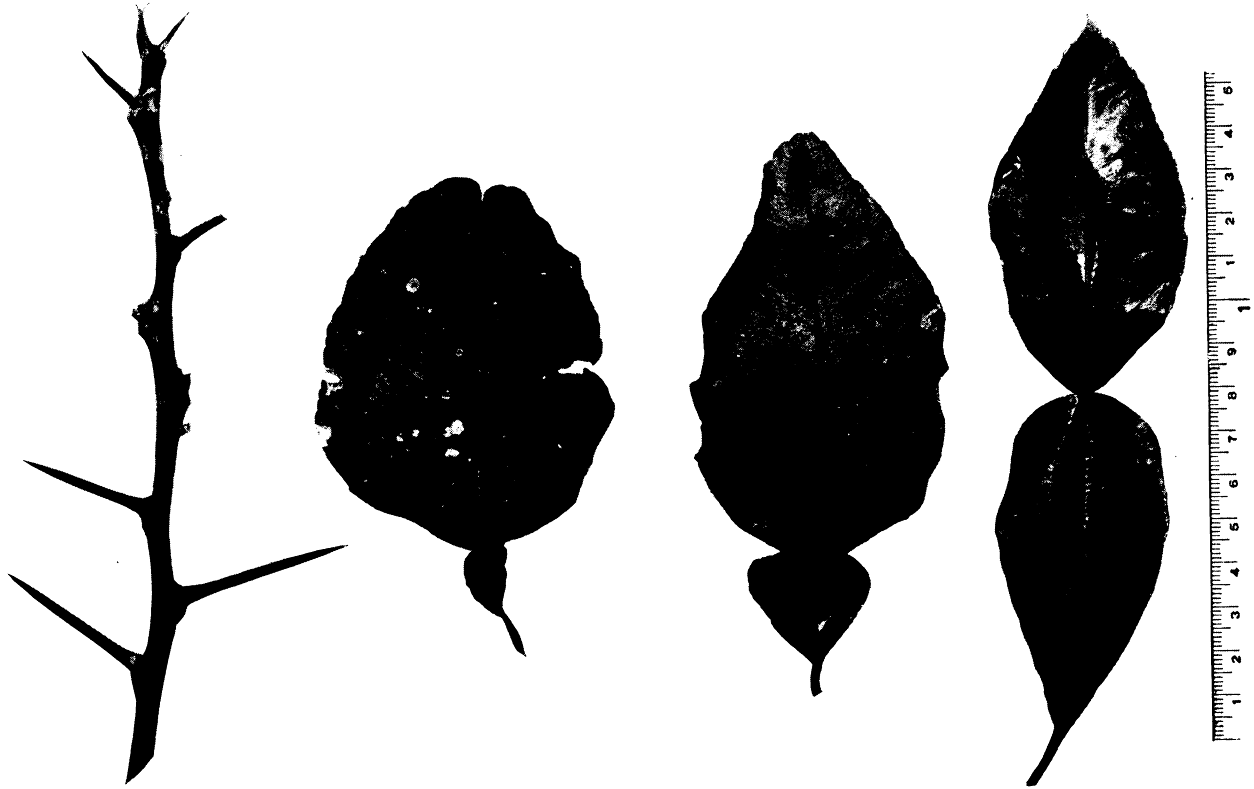
(*a*) Javanese cinchona Plantation. (Planting cinchona in the foreground, old cinchona trees in the background.)

Courtesy of the Department of Agriculture, Buitenzorg, Java.

(*b*) View on a cinchona estate, Java. (Young plants in the foreground, old cinchona trees in the background.)

Courtesy of the Department of Agriculture, Buitenzorg, Java.

PLATE IV.



Citrus leaves and twig showing infection by canker.

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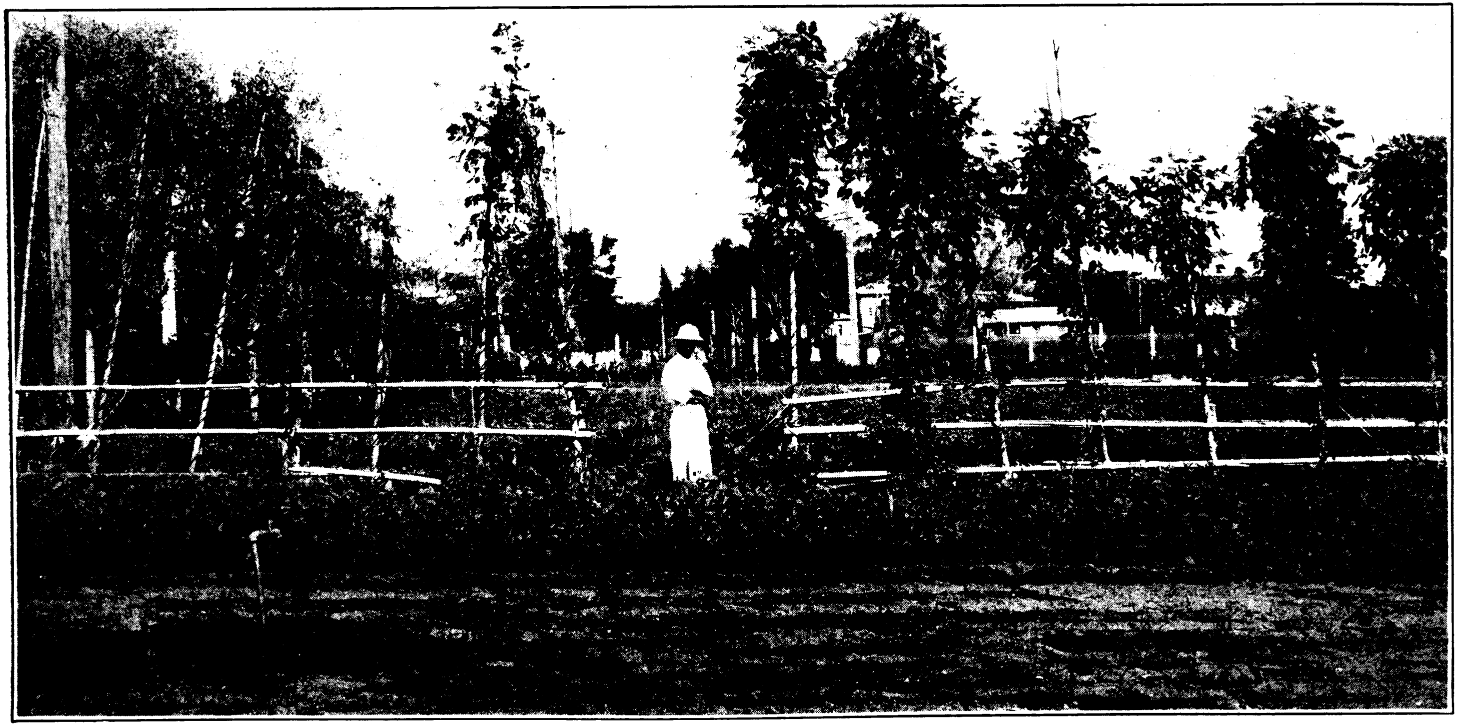

Stizolobium Beans.

Spotted bean on the left, hybrid bean on the right. Although both beans were planted the same day, it will be noticed that nearly all the leaves of the spotted bean have fallen and that the vines are practically mature, while the hy brid-bean vines are still in a growing condition.

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PLATE VI.

(*a*) Stizolobium beans showing the development of the spotted-bean vine, about four months after planting. The leaves have nearly all fallen and many of the pods can be seen to be partially mature. Compare this with (*b*), the Lyon bean, planted the same day only a few yards distant.

(*b*) The Lyon-bean vine showing leaves, flowers, and pod clusters in several stages of development.

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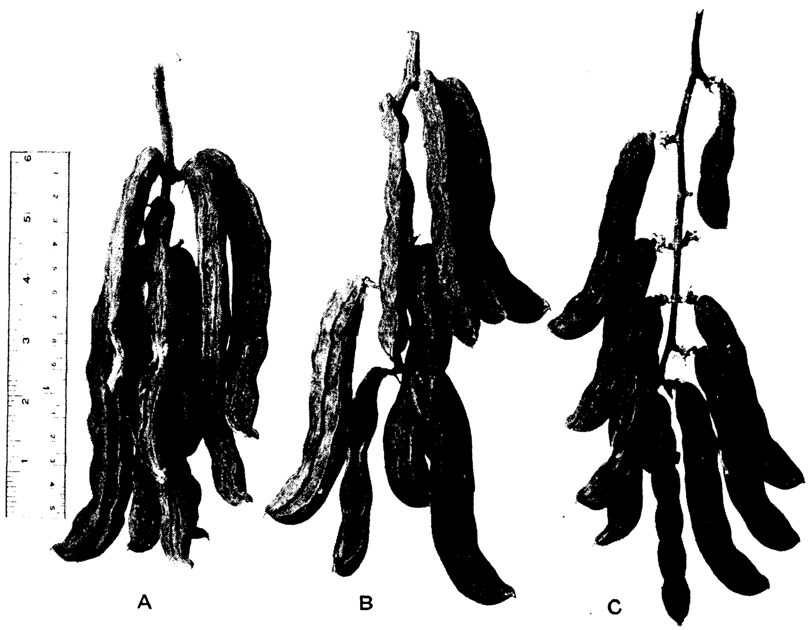
(*a*) Stizolobium beans. Pod cluster, individual pods, and seeds of the hybrid bean. The seed varies somewhat as to size and degree of mottling, but seems near enough of one type to be a "fixed hybrid."



(*b*) A, cluster of pods of the spotted bean; B, the hybrid bean; and C, the Lyon bean. The number of pods per cluster is nearly the same in these three Stizolobiums, but the pods of both the spotted and hybrid beans are larger than those of the Lyon bean.

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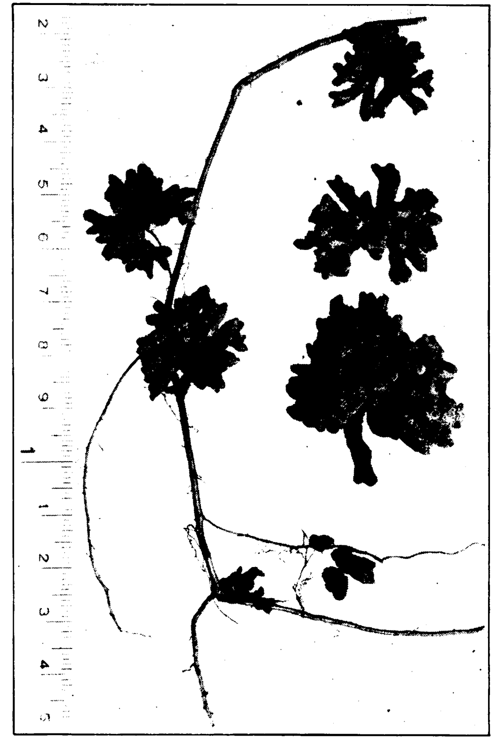
PLATE VIII.

(*a*) Stizolobium beans. A, Spotted bean; B, various types and sizes of the marble bean, found mixed with the Lyon bean; and C, the Lyon bean as grown at the La Carlota Experiment Station in which the other beans were found.

(*b*) Leaf and flowers of the spotted bean.



(*c*) Root nodules of spotted bean.

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Sep. 23, 1915: First flowers appeared, purple.
Oct. 1, 1915: Vines 8.10 meters long. Leaves did not wilt so quickly, and also showed more reaction to sun's rays than the other types of plants.
Oct. 15, 1915: Root nodules averaged over 2 centimeters in diameter.
Dec. 15, 1915: First entirely ripe pods found.
Jan. 12, 1916: Harvested plot and shelled pods; yield of seed practically one kilogram. No apparent mixture. Pods from 4 to 8 per bunch as a rule, and 3 to 7 seeds per pod.

Mr. E. D. Doryland, superintendent of the Singalong experiment station, assisted in making observations and in taking data on this experiment, but neither he nor the writer noticed any appreciable differences in vine, leaf, flower, pod, or seed characters in any of the plots; all seemed apparently pure strains of seed. From the results of this test it seemed that the spotted bean in Plot III was much superior to the marbled or the Lyon beans in many respects. It made a more rapid initial growth of vine, the root nodules were fully as numerous and slightly larger, it flowered about a month earlier, the pods ripened sooner and nearer the same time than did the other two beans, and there was no apparent shattering of the seed as in the Lyon beans. (Pl. VI.)

The marbled bean in Plot II is probably equal, and slightly superior to the Lyon bean. It outclassed the Lyon bean in growth of vine, the seed showed a tendency to mature slightly earlier and the pods did not shatter their seed. On the other hand, it produced a rather coarse vine.

In tests being carried on at the Singalong and La Carlota experiment stations at the present time, all of the results secured in this test have been confirmed, excepting the pod and seed characters, the pods having not yet fully matured.

A new point brought out in the tests, now being carried on at La Carlota, is the ability of the hybrid and the spotted beans to withstand a fungous disease, apparently rust.

These beans hardly showed signs of infection, while the Lyon-bean vines, not two meters away, were badly infected and apparently checked in growth. Another point is that the vines of both of these beans apparently grow more rapidly than do those of the Lyon bean, in both wet and dry seasons. When planted under equal conditions in the field, these two beans covered the ground about two weeks earlier than did the Lyon beans.

Although the tests now being carried on at the La Carlota and Singalong stations need to be completed before this will be known conclusively, it appears from the results of the tests already finished that both the marbled and the spotted beans are new

types of Stizolobium. As stated before, it is thought that the marbled bean is a hybrid of the Lyon and Florida velvet bean, becoming mixed with the Lyon beans at Lamao, and carried to La Carlota in the Lyon seed. No tendency to revert to the Lyon or the Florida velvet bean was shown by the vines or in the seed of the plants produced from hybrid seed planted at Singalong, and their progeny now growing at La Carlota seen uniformly of this same type. It seems possible that it may prove to be a so-called "fixed hybrid," as the vine, leaf, flower, pod and seed characters in all tests so far completed appear to have been the same in each plant.

The spotted bean, as before mentioned, compares very closely with the fleshy-pod bean (*S. pachylobium*) as described by Piper and Tracy in Bulletin No. 179, B. P. I., United States Department of Agriculture, and also in the Annual Report for 1913 of the Hawaii Agricultural Experiment Station. It apparently corresponds to these descriptions in all but three respects:

1. Flowers appear in less than two months, instead of from 3 to 5 months after sowing. This has occurred during both the wet and the dry seasons in the Philippines.
2. The seed has ripened in less than 200 days and earlier than the Lyon bean which matures in a shorter time than does the Florida velvet bean. The seed has reached maturity in 5 months.
3. Pods are not as a rule borne in bunches of more than 8, a few exceptions of 12 to 15 having been found. Both the Hawaii report and Bulletin No. 179, B. P. I., state that as many as 50 pods per cluster are found.

It seems possible that the origin of this bean may be similar to that of the Georgia velvet bean, as explained by Mr. John Belling of the Florida Experiment Station, in his short article printed in "The Journal of Heredity" of July, 1915.

The Georgia velvet bean is described as a "mutant" from the Florida velvet bean, having lost the factor for late maturing which the Florida is credited with having. It apparently differs from the Florida only in maturing considerably earlier.

According to the descriptions of the fleshy-pod bean it is later maturing than the Florida velvet bean. It seems possible that the fleshy-pod bean also has the dominant factor, as described as the cause for late maturing in the Florida velvet bean. Probably this spotted bean found in the Lyon bean is also a mutant caused by the loss of this factor for late maturing.

Along with the factor for late maturing, this bean apparently has lost the factor for producing large cluster of pods. The average number of pods to the cluster is from 4 to 8, and few of

more than 10 have been found. The fleshy-pod bean, as described, produces as many as 30 to 50 pods to the cluster. This bean has been grown to maturity both during the wet and dry seasons here in the Philippines and no clusters of over 15 pods have ever been noticed.

There is still room for doubt as to whether this is a mutant or not, which, however, can only be cleared up by growing this bean is comparison with the original type.

The following is a detailed description of this bean:

A stout, herbaceous, branching, twining vine, slightly pubescent, reaching a length of at least 4 meters on the ground and 10 on supports, has a pronounced purplish pigmentation; leaves thin, membraneous, ovate-acute, lateral leaflets oblique, midribs often at right angles to central leaflets, vary from 10 to 20 centimeters long and 6 to 10 centimeters wide, very slight white pubescence both above and beneath; more pronounced on lower side, especially on veins; petioles from 20 to 60 centimeters long; flowers are borne on racemes; calyx grayish, pubescent, sometimes with a few scattering coarser black hairs; corolla dark purple, pods borne in clusters of as many as 12, usually 4 to 8, vary from 10 to 15 centimeters long, 15 to 18 millimeters wide; valves usually with one or two deep longitudinal ribs, and several less pronounced ones, slightly compressed between seed compartments, slight gray pubescence when young, black or gray when mature; seeds 4 to 6 in pod, much compressed, mottled black or brown on ash gray, markings often tend to run longitudinally, nearly the length of the seed; veins of testa can be distinguished, hilum oblong, crateriform, less than half the seed length, ash-gray, with spots of brown or black; seeds have slight depressed spot over embryo.

Blossoms noticed as early as 43rd day after germinattion, and seed to mature in about 5 months.

Regardless of the possible origin of this plant, it seems interesting from an economic view point, since it has apparently shown itself superior to the Lyon bean which is considered a valuable cover crop.

It is believed that since this bean is able to produce root nodules so numerously, makes such a large initial growth of vine, blossoms so early, matures its seed sooner and more evenly than the Lyon bean, and apparently earlier than the Florida velvet bean, does not shatter its seed, and has no stinging hairs on the pods, it is likely to prove a valuable cover crop for the south. If this bean will mature in five months in the United States, as it has done in the Philippine Islands, it can probably be grown to maturity considerably farther north than many of the other Stizolobiums.

RINDERPEST IN SWINE, WITH EXPERIMENTS UPON TRANSMISSION FROM CATTLE AND CARABAOS TO SWINE AND VICE VERSA.

By WILLIAM HUTCHINS BOYNTON, *Pathologist, Bureau of Agriculture.*

INTRODUCTION.

This investigation was commenced fòr the purpose of positively determining the role which pigs may play in the spread of rinderpest in the Philippine Islands.

During several years of experience in handling rinderpest in the field, Doctor Youngberg, chief veterinarian, Bureau of Agriculture, has frequently noticed, and has also received reports from veterinarians on rinderpest quarantine work in the field, that in localities where rinderpest is present, pigs also develop an ailment practically simultaneous with the appearance of rinderpest in cattle and carabao.

There is one instance where it was practically proved that pigs were the cause of an outbreak of rinderpest among cattle, carabaos and swine in the Philippines. In February, 1908, Doctor Youngberg was ordered to investigate, on the Island of Romblon, an outbreak of disease which was causing serious losses among the cattle and carabaos.

The disease proved to be rinderpest, and this was the first time it had made its appearance on that island. The outbreak was very virulent and the mortality high.

It was at first difficult to account for the introduction of the disease as no cattle or carabaos has been imported there for a long time. It was ascertained that hogs had been and were being imported, however, from Capiz, a province on the Island of Panay, situated some seventy-five miles south of Romblon. At that time rinderpest was prevalent in Capiz Province.

Information was obtained to the effect that hogs which had been kept in the same pens with those imported from Capiz first sickened and many died; after this other hogs in the village became infected and then the carabaos and cattle began to die. During this outbreak it was noticed that when a village was found infected with rinderpest, the hogs had first died in considerable numbers.

Although these facts were reported by Dr. Youngberg to the Bureau of Agriculture, the essential point of the possibility of hogs being the prime factor in the introduction of this disease was unfortunately overlooked by the authorities in charge.

As the mortality was as a rule not high among the pigs, and since the native pig is not a very thrifty-appearing individual, and since swine plague, hog cholera, kidney-worm infestation and *Balintindium coli suis* are quite prevalent throughout the Islands, the definite connection between rinderpest in cattle and carabaos and the ailment in pigs was overlooked. It was supposed that the pigs were suffering from one or more of the above-mentioned diseases, and that their unthriftiness was mangnified by the fact that all animals in infected areas under quarantine were watched much more closely by the veterinarians and live-stock inspectors in charge than in rinderpest-free districts.

During 1914, while the writer was on vacation, hog cholera broke out among the pigs at the Bureau of Agriculture stock farm at Alabang, Rizal Province. Mr. Thomas L. Bean, assistant in the veterinary research laboratory, made the hog-cholera serum and immunized these pigs. Upon completing this work six pigs hyperimmunized to hog cholera were left at the laboratory. These six pigs were exposed separately to cattle sick with rinderpest, as will be noted in experiments 43 to 48 in this paper, and each one developed symptoms similar to those caused by rinderpest in cattle.

There is but little literature upon the subject of rinderpest in swine, and this little is contradictory.

Messrs. Carré and Freimbault(1), in the course of research work upon rinderpest in Indo-China, performed some experiments upon pigs. They demonstrated the possibility of transmitting rinderpest from pig to pig by contact, as well as by blood inoculation. They also demonstrated that it was possible to transmit rinderpest by blood inoculation from bull to pig and from pig to bull.

Messrs. Carré and Freimbault also mention M. Leblanc as having found rinderpest among peccaries in 1886, and that Penning had announced the transmission of rinderpest to the wild boar.

Friedberger and Frohner(2) mention Pluning as having noticed rinderpest in swine in Sumatra and that the symptoms and lessions were the same as those found in cattle.

The same authors mention Theiler as being unable to transmit rinderpest to swine by inoculating them with blood from rinderpest-sick cattle.

Hutyra and Marex(3) state that the question of rinderpest in swine is not definitely settled, undoubtedly basing their statement on the contradictory results obtained by different workers. They cite Carré and Freimbault, Penning, and Theiler.

Dr. James W. Jobling(4) in his annual report for 1903, cites an experiment upon rinderpest in pigs in the Philippine Islands. In this experiment he injected a farm-bred hog with 5 cubic centimeters of virulent rinderpest blood from a bull. The hog developed typical symptoms of rinderpest. Blood was taken from it and injected into a hog and a bull. The hog which received this blood did not develop any symptoms of the disease. The bull which received the blood taken from the sick pig developed typical symptoms of rinderpest but ran a mild course of the disease, and was bled to death. Upon autopsy this animal presented lesions of rinderpest but not so far advanced as is usually noticed.

In concluding this experiment Doctor Jobling says:

> This hog had the shortest incubation period of any animal I have seen, and I would have believed it to be suffering from some other disease had cow No. 46 not developed typical rinderpest after the regular incubation period.
>
> From this one series of experiments it would appear that while the hog may contract the disease and die, and its excreta may form a source of infection for cattle and carabaos, yet it is difficult for the sick hog to re-infect others of its kind. However, no definite conclusions could be based upon the evidence at my disposal, and the work will be continued when opportunity offers.

Doctor Jobling also mentions the possibility of wild hogs spreading the disease in the provinces.

It may be mentioned here, as will be noted in the following experiments, that hogs have as a rule a shorter incubation period, and show a higher temperature during the course of the disease, than do cattle and carabaos. The shortness of the incubation period may be accounted for by the fact that hogs are natural scavengers and when exposed to cattle and carabaos sick with rinderpest, they devour large quantities of feces from these sick animals and in this way saturate their systems immediately with large quantities of the virus, which is always present in abundance in the discharges of animals from the time of the initial rise in temperature to the time of recovery or death.

It has been noted by Doctor Youngberg, when virulent rinderpest blood taken from pigs was used in immunization work in the provinces, that the virus was activated and better reactions were as a rule obtained than where the virulent blood was

taken from cattle or carabaos. Also virulent blood from hogs mixed with virulent blood from cattle or carabaos had a tendency to activate the virus.

In a personal conversation Prof. Dr. T. Horiuchi, of the bacteriological institute of Formosa, informed the writer that he had seen pigs infected with rinderpest in that island. In his experience it was of rare occurrence that cattle became infected from pigs.

PIGS EXPOSED TO CATTLE SICK WITH RINDERPEST.

The following ten experiments were designed to furnish information regarding the possibility of pigs contracting rinderpest through contact with cattle sick with the disease.

These exposures were conducted in two stalls, which will be designated as stall No. 1 and stall No. 2. The dimensions of these stalls were 10 feet in length by 12 feet in width. Stall No. 1 had a cement, and stall No. 2 a wooden floor.

The sick cattle were tied in these stalls and the pigs were unrestrained during the exposures.

All the animals used in these experiments were kept in quarantine for a certain length of time, which will be stated in each case. While in quarantine their temperatures were taken twice a day, morning and afternoon, and each day their general physical condition was noted.

The following abbreviations will be used in connection with the data on the experiments: D., diarrhea; E. L., eating little; N. E., not eating; D., E. L., diarrhea, eating little; D., N. E., diarrhea, not eating; V. B., virulent blood.

EXPERIMENT 1.

Pig 185.—Known history prior to the experiment. This animal was a native pig, 7 months old, purchased in Manila, and placed in quarantine at the laboratory March 2, 1915. On May 2, 1915, it was inoculated with 50 cubic centimeters of blood from a pig suffering from hog cholera. This blood had been passed through a Burgerfeld N. filter. The animal developed a mild form of hog cholera and recovered.

May 21, 1915, pig 185 was exposed to bull 3906 in stall No. 1. This exposure was continued for three days.

History of bull 3906 during the exposure:

May 21: Fifth day after the initial rise in temperature.
May 21–23: D., N. E.
May 24: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

May 25, pig 185 developed a rise in temperature, registering, p. m., 40.1° C. This was four days after the initial exposure to bull 3906.

May 26, pig 185 was transferred to corral No. 1, to accomplish experiments Nos. 11 and 23.

May 27, this animal showed a p. m. temperature of 40.9° C. which was the highest temperature registered during the course of the disease. It was bled and the blood used in experiment 29.

May 28–31, N. E.

June 1–9, E. L.

This animal gradually recovered from rinderpest, but did not become thrifty and was killed August 7, 1915.

EXPERIMENT 2.

Pig 207.—Known history prior to the experiment. This animal was a native pig, 7 months old, purchased in Manila and kept in quarantine twenty days before being used. At no time during this period did it have a high temperature or show any symptoms of sickness.

June 17, 1915, pig 207 was exposed to bull 3908, first day of temperature, and bull 3926, sixth day of temperature. This exposure was made in stall No. 1 and was continued for five days.

History of bull 3908 during the exposure:

- June 17: First day of temperature, registering, a. m., 38.5° C., p. m., 39.3° C.
- June 22–25: D., N. E.
- July 4: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of bull 3926 during the exposure:

- June 17: Sixth day after the initial rise in temperature, N. E.
- June 18–20: D., N. E.
- June 21–22: D.
- This animal gradually recovered.

June 21, pig 207 developed a rise in temperature, registering, p. m., 40.1° C.; this was four days after the initial exposure to bulls 3908 and 3926.

June 22, pig 207 was transferred to corral No. 1 to accomplish experiment 24.

June 24, this animal showed a p. m. temperature of 41.2° C., which was the highest temperature it developed during the course of the disease.

June 30 to July 2, this animal had a slight diarrhea and ate but little.

The pig gradually recovered from rinderpest but did not become thrifty and was killed on August 7, 1915.

EXPERIMENT 3.

Pig 208.—Known history prior to experiment. This animal was a native pig, six months old, purchased in Manila, and kept in quarantine forty days before it was used. At no time during this period did it have a high temperature or show any symptoms of sickness.

July 19, 1915, pig 208 was exposed to bull 3939, fifth day of temperature, and bull 3931, fourth day of temperature, in stall No. 1. This exposure was continued two days with bull 3939 and four days with bull 3931.

History of bull 3939 during the exposure:
- July 19: Fifth day of temperature, D., N. E.
- July 20: D., N. E.
- July 21: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of bull 3931 during the exposure:
- July 19: Fourth day of temperature.
- July 21–22: N. E.
- July 22: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

July 23, pig 208 developed a rise in temperature, registering, p. m., 40.4° C.; this was four days after the initial exposure to bulls 3939 and 3931.

July 27, pig 208 was removed to corral No. 1 to accomplish experiments 12 and 25. It presented an a. m. temperature of 39.9° C. and a p. m. temperature of 41.2° C.

July 31 to August 7, E. L.

August 3, it presented a p. m. temperature of 41.6° C. which was the highest temperature registered during the course of the disease.

August 8–11, D., E. L.

August 12, died of rinderpest, presenting typical lesions of that disease upon autopsy.

EXPERIMENT 4.

Pig 215.—Known history prior to experiment. This animal was a native pig, 8 months old, purchased in Manila, and kept in quarantine seventy-two days before it was used. At no time during this period did it have a high temperature or show any symptoms of sickness.

September 30, 1915, pig 215 was exposed to bull 3925 which was on the third day after the bull's initial temperature was recorded. This exposure was continued for four days in stall No. 1.

History of bull 3925 during the exposure:
- September 30: Third day of temperature.
- October 1–3: D., N. E.
- October 3: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

October 3, pig 215 developed a rise in temperature, registering, p. m., 40.2° C.; this was three days after the initial exposure to bull 3925.

October 4, it presented a p. m. temperature of 40.9° C. which was the highest temperature registered during the course of the disease.

October 6–12: D., N. E.

October 13–16: D.

This animal gradually recovered from rinderpest but did not become thrifty and was killed December 4, 1915.

EXPERIMENT 5.

Pig 213.—Known history prior to experiment. This animal was a native pig, 7 months old, purchased in Manila, and kept in quarantine twenty-eight days before it was used. At no time during this period did it have a high temperature or show any symptoms of sickness.

August 17, 1915, pig 213 was exposed to bull 3928, first day of temperature, in stall No. 1.

History of bull 3928 during the exposure:
- August 17: First day of temperature, p. m., 39.9° C.
- August 18: a. m., temperature 39.6° C., p. m., temperature 40.8° C.
- August 23: N. E.
- August 24–29: D., N. E.
- August 30–31: E. L.
- This animal gradually recovered.

August 25, pig 213 presented a rise in temperature, registering, p. m., 39.9° C.; this was eight days after the initial exposure to bull 3928.

This animal showed a rather high temperature until September 10, when its temperature subsided to normal and recovery was prompt. At no time during this period did the animal present any severe symptoms such as diarrhea or inappetence. It ran a mild course of the disease throughout, which is occasionally observed in cattle and carabao.

EXPERIMENT 6.

Pig 220.—Known history prior to experiment. This animal was a native pig, 7 months old, purchased in Manila, and kept in quarantine forty-nine days before it was used. At no time

during this period did it have a high temperature or show any symptoms of sickness.

October 9, 1915, pig 220 was exposed to bull 3938, second day of temperature, in stall No. 1. This exposure was continued for six days.

October 14, bull 3958, first day of temperature, was admitted to stall No. 1. This exposure was continued for eight days.

October 19, bull 3961, first day of temperature, was admitted to stall No. 1. This exposure was continued for three days.

History of bull 3938 during the exposure:
- October 9: Second day of temperature, a. m., 39.9° C.
- October 12–14: D., N. E.
- October 15: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of bull 3958 during the exposure:
- October 14: Initial rise in temperature, a. m., 39.3° C.; p. m., 40.4° C.
- This animal ran a high temperature until October 22 when the temperature subsided to normal. It did not develop diarrhea or inappetence, but ran a mild course of the disease.

History of bull 3961 during the exposure:
- October 19: Initial rise in temperature, a. m., 39.6° C.; p. m., 40.6° C.
- October 21: D.
- October 22: D., N. E.
- October 23: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

October 16, pig 220 showed a rise in temperature registering, p. m., 40.8° C.; this was seven days from the time of the initial exposure.

October 18–19, the p. m. temperatures were 40.8° and 40.9° C., respectively.

October 25, this animal's temperature had dropped to normal and recovery was prompt.

At no time did this animal present severe symptoms such as diarrhea and inappetence, but ran a mild course of the disease.

EXPERIMENT 7.

Pig. 240.—Known history prior to experiment. This animal was a native pig, 8 months old, purchased in Manila, and kept in quarantine thirty-six days before it was used. At no time during this period did it have a high temperature or show any symptoms of sickness.

November 20, 1915, pig 240 was exposed for one day in stall No. 1 to bull 3972 which was on the sixth day after its initial rise in temperature.

Also to bull 3988 for three days in stall No. 1, this animal developing its initial rise in temperature on this day.

History of bull 3972 during the exposure:
- November 20: Sixth day of temperature, D., N. E.
- November 21: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of bull 3988 during the exposure:
- November 20: Initial rise in temperature recorded; p. m. temperature 41° C.
- November 25: This animal was bled to death to secure virulent blood for immunizing purposes.

November 23, pig 240 presented a rise in temperature, registering, p. m., 40.2° C.; this was three days from the time of the initial exposure.

November 24–26, N. E.

November 26, transferred to stall No. 2 to be used in experiment 27.

November 27–28, D., N. E.

November 29, E. L.

This animal gradually recovered but later contracted hog cholera.

EXPERIMENT 8.

Pig 155.—Known history prior to exposure. This animal was a Berkshire sow about 10 months old; it was brought to the laboratory from the Bureau of Agriculture experiment station at Alabang on October 13, 1915, and was kept in quarantine fifty-two days before being used. During this period at no time did it have a high temperature or show any symptoms of sickness.

December 3, 1915, pig 155 was exposed for two days to bull 3981, in stall No. 2. At the beginning of the exposure this bull was on its sixth day of temperature.

Also to bull 3983 for three days in stall No. 2. At the beginning of exposure this bull was on the fifth day of temperature.

History of bull 3981 during the exposure:
- December 3: Sixth day of temperature, D., N. E.
- December 4: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of bull 3983 during the exposure:
- December 3: Fifth day of temperature, D., N. E.
- December 4: D., N. E.
- December 5: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

December 12, pig 155 developed an a. m. temperature of 40.2° C.; this was nine days from the time of the initial exposure.

This animal had a high temperature until December 21, at which date the temperature subsided to normal.

This animal ran a mild course of the disease, never showing severe symptoms such as diarrhea and inappetence.

EXPERIMENT 9.

Pig. 237.—Known history prior to exposure. This animal was a native pig, 5 months old, purchased in Manila, and kept in quarantine seventy-five days before it was used. During this period at no time did it have a high temperature or show any symptoms of sickness.

December 29, 1915, pig 237 was exposed to bull 3966, which was on its fifth day of temperature. This exposure lasted two days in stall No. 2.

Also to bull 3976 for five days in stall No. 2, commencing on the initial rise of temperature in the bull.

History of bull 3966 during the exposure:

December 29: Fifth day of temperature, D., N. E.

December 30: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of bull 3976 during the exposure:

December 29: First day of temperature, a. m., 39° C.

January 3, 1916: Bled to death for virulent blood to be used in immunization work.

January 2, 1916, pig 237 developed an a. m. temperature of 41.2° C.; this was four days after the initial exposure.

January 3, this pig was bled to death for virulent blood to be used in immunization work.

EXPERIMENT 10.

Pig 242.—Known history prior to exposure. This animal was a native pig, 6 months old, purchased in Manila and kept in quarantine seventy-six days before it was used.

This animal arrived at the laboratory on October 15, 1915. On October 26, it was noticed to have a high temperature and on October 28 developed a diarrhea. The diarrhea continued until November 9, and the high temperature until November 16, when it subsided to and remained normal. This condition was diagnosed as hog cholera, as another pig which had been kept in quarantine with this one developed similar symptoms just prior to this time. It was killed, and at autopsy presented good lesions of hog cholera.

January 30, 1916, pig 242 was exposed in stall No. 2 for three days to bull 3960 which was on its fourth day of temperature.

History of bull 3960 during the exposure:
- January 30: Fourth day of temperature.
- January 31: D., N. E.
- February 1: Died of rinderpest, representing typical lesions of that disease.

February 2, 1916, pig 242 developed an a. m. temperature of 39.8° C. and a p. m. temperature of 41° C.; this was three days after the initial exposure.

February 4–5, E. L.

February 6–7, N. E.

February 7, died of rinderpest, presenting typical lesions of that disease upon autopsy.

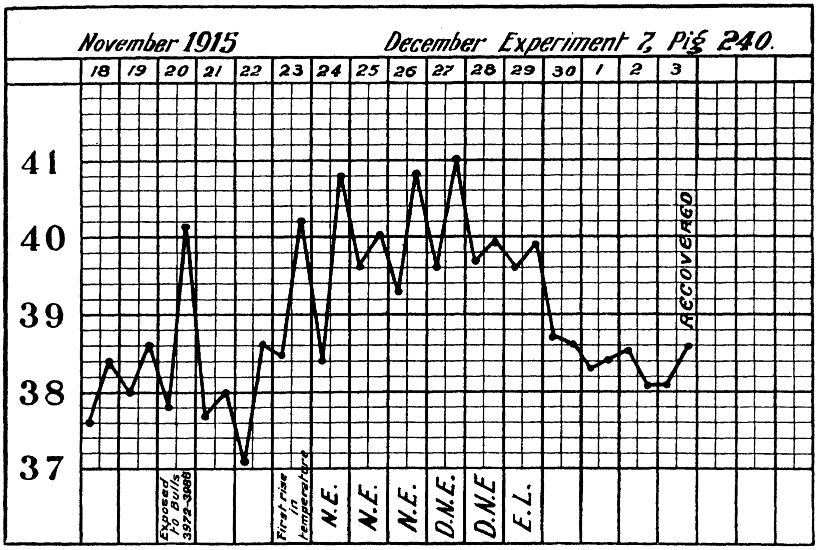

CHART I. Pig exposed to bull.

In summing up the results of the ten preceding experiments on the exposure of pigs to cattle sick with rinderpest, it will be noted that all the pigs contracted a disease and developed symptoms characteristic of rinderpest in cattle and carabao.

Three of the animals developed their initial rise in temperature on the third day, four on the fourth day, one on the seventh day, one on the eighth day, and one on the ninth day of exposure. From this it will be noted that the incubation period of rinderpest in pigs which have been exposed to cattle sick with that disease, corresponds very closely to the incubation period in cattle and carabao, in which it varies between three and ten days, averaging five days.

Of the ten pigs used, two, or 20 per cent, died of rinderpest. Four, or 40 per cent, recovered from the disease, but were unthrifty and were killed, although under normal conditions these animals would undoubtedly have been allowed to live. Of these four, one contracted hog cholera. Three, or 30 per cent, presented very mild symptoms, showing only a temperature reaction and recovered promptly; these animals under normal field conditions would hardly have been suspected of being sick. One, or 10 per cent, was bled to death for virulent blood, leaving the final outcome as to the effect of the disease uncertain.

These 10 pigs were exposed to 19 head of cattle sick with rinderpest. Of these 19 head, 14 or approximately 73.7 per cent, died of rinderpest. Three, or approximately 15.8 per cent, recovered. Two, or approximately 10.5 per cent, were bled to death for virulent blood, leaving the final outcome as to the effects of the disease uncertain.

In comparing these figures it will be noted that the mortality in cattle was 73.7 per cent against 20 per cent in pigs, and that the recovery in cattle was 15.8 per cent against 70 per cent in pigs when the mild cases and those that recovered but were unthrifty are figured together.

Thus it will be seen that rinderpest in pigs, when contracted by exposure, presents a low mortality as compared with its effect upon cattle.

PIGS EXPOSED TO PIGS SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of pigs contracting rinderpest by contact with pigs sick with that disease.

These exposures were conducted in two different corrals which will be designated as corral No. 1 and corral No. 2. The dimensions of corral No. 1 were 14 by 30 feet, and of corral No. 2, 16 by 30 feet. Both corrals were built on the ground and both contained a small lean-to shed, to protect the animals from the weather.

The sick pigs and those placed in the corrals to be exposed were allowed the freedom of the place.

All the animals used in these experiments were kept in quarantine a certain length of time, which will be stated in each case. While in quarantine their temperatures were taken twice a day, morning and afternoon, and each day their general physical condition was noted.

EXPERIMENT 11.

Pig 186.—Known history prior to the exposure. This animal was a native pig, 6 months old, purchased in Manila, and brought to the laboratory and placed in quarantine on March 2, 1915.

On May 2, 1915, this animal was inoculated with 50 cubic centimeters of blood from a pig suffering from hog cholera. This blood had been passed through a Burgerfeld N. filter. The animal developed a mild form of hog cholera and recovered. At no other time than when suffering from the mild attack of hog cholera did the animal have a rise in temperature or show any symptoms of sickness.

May 26, 1915, pig 186 was exposed to pig 185 in corral No. 1; this was the second day of temperature for pig 185. The exposure was continued for sixteen days.

History of pig 185 during the exposure.

Referring to experiment 1, it will be noted that pig 185 contracted the disease from bull 3906.

May 26: a. m. temperature 39.1° C.; p. m. temperature 40.5° C.

May 27: a. m. temperature 40.2° C.; p m. temperature 40.9° C.

May 28–31: N. E.

June 1–9: E. L.

May 30, pig 186 developed a rise in temperature, registering, a. m. 39.8° C.; p. m., 40.6° C. This was four days after the initial exposure to pig 185.

May 31, p. m. temperature 41.6° C., which was the highest temperature registered during the course of the disease.

June 1–4, D., N. E.

June 9–10, D., E. L.

June 15–16, D.

This animal gradually recovered but did not become thrifty and was killed August 7, 1915.

EXPERIMENT 12.

Pig 212.—Known history prior to experiment. This animal was a native pig, 5 months old, purchased in Manila and kept in quarantine eight days before it was used. On the first day in quarantine it registered a p. m. temperature of 40.4° C., which was undoubtedly due to excitement since the temperature subsided to normal on the following day and remained so until after it was used, and at no time prior to the exposure did it manifest any symptoms of sickness.

July 27, 1915, pig 212 was exposed to pig 208 in corral No. 1; this was the fifth day of temperature for pig 208. The exposure was continued for fifteen days.

PLATE IX.

A group of pigs sick with rinderpest.

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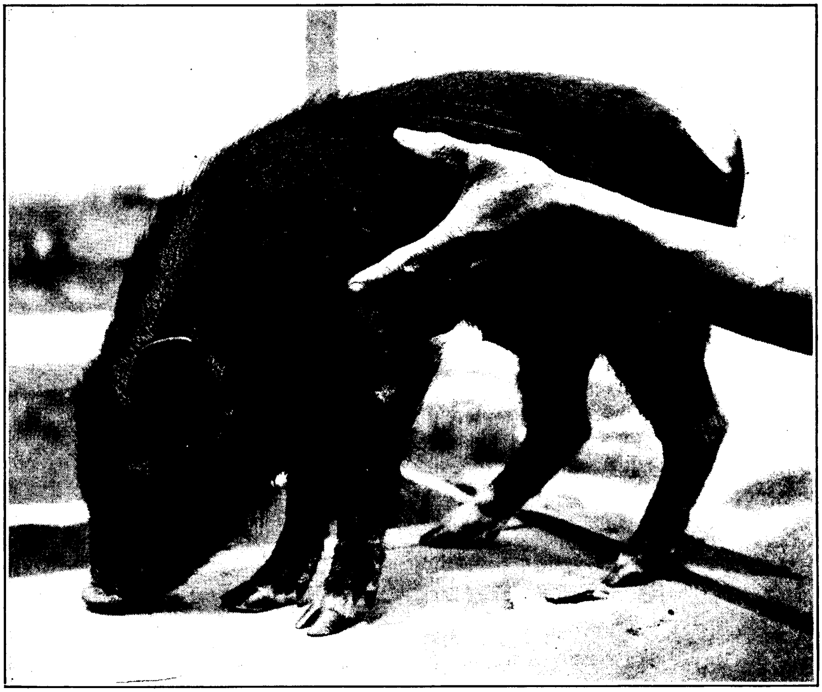
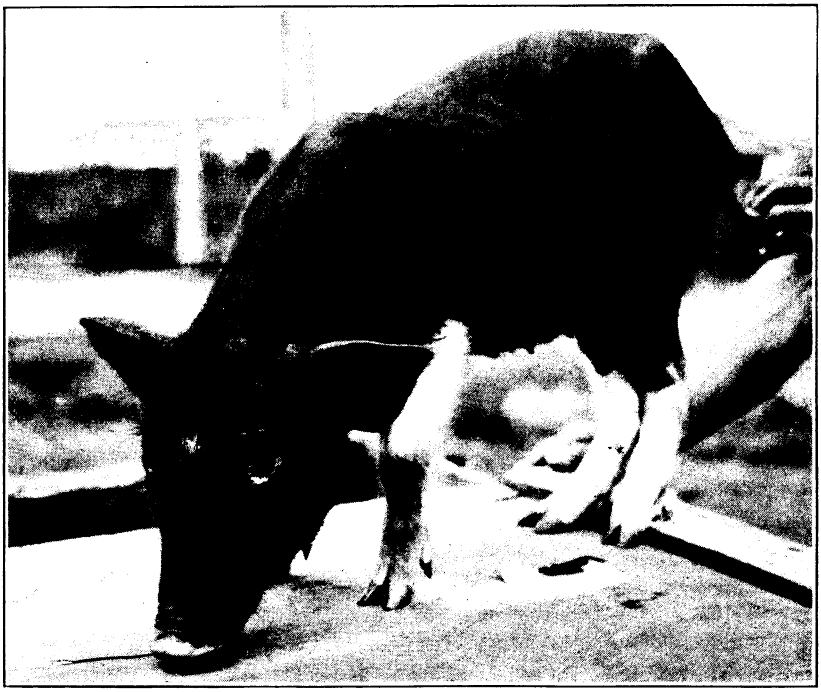


(*a*) A pig in the last stages of rinderpest.



(*b*) A pig in the last stages of rinderpest possessing marked eye lesions.

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History of pig 208 before and during the exposure:

Referring to experiment 3, it will be noted that pig 208 contracted the disease from bull 3939 and bull 3931.

July 27, fifth day of temperature, a. m., 39.9° centigrade, p. m., 41.2° centigrade.

July 31–August 7: E. L.

August 8–11: D., E. L.

August 12: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

August 1, pig 212 developed a rise in temperature, registering, a. m., 40.6° C.; p. m., 41.6° C.; this was on the fifth day after the initial exposure to pig 208.

August 3–7, E. L.

August 9–11, D., N. E.

August 11, died of rinderpest, presenting typical lesions of that disease upon autopsy.

EXPERIMENT 13.

Pig 218.—Known history prior to the experiment. This animal was a native pig, 8 months old, purchased in Manila and placed in quarantine at the laboratory on August 21, 1915, where it was kept forty-five days before it was used. At no time during this period did it have a high temperature or show any symptoms of disease.

October 5, 1915, pig 218 was exposed to pig 216 in corral No. 1; this was the third day of temperature for pig 216. The exposure was continued for one day.

History of pig 216 before and during the exposure:

Referring to experiment 17 it will be noted that pig 216 was inoculated with 6 cubic centimeters of virulent rinderpest blood from bull 3925.

October 5: D., N. E., and vomiting.

October 6: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

October 9, pig 218 developed a rise in temperature, registering a. m., 40.4° C.; p. m.; 41.6° C.; this was on the fourth day after the initial exposure to pig 216.

October 11–12, E. L.

October 13, died of rinderpest, presenting typical lesions of that disease upon autopsy.

In summing up the results of experiments 11, 12, and 13, on the exposure of susceptible pigs to pigs sick with a disease they had contracted from cattle sick with rinderpest, these pigs manifesting symptoms agreeing with the symptons of rinderpest in cattle and carabao, and finally upon autopsy after death presenting

lesions characteristic of that disease in cattle, it will be noted that the pigs exposed to these sick ones promptly developed a disease which possessed all the characteristics of rinderpest. Two of the animals developed a rise in temperature on the fourth day after the initial exposure and one on the fifth day, which time corresponds very closely with the incubation period of rinderpest in cattle and carabaos.

Of the three animals used, two, or $66\frac{2}{3}$ per cent, died, and one, or $33\frac{1}{3}$ per cent, recovered, which also agrees very closely with the effects of rinderpest on cattle and carabaos.

Although the animal in experiment 11 was finally destroyed

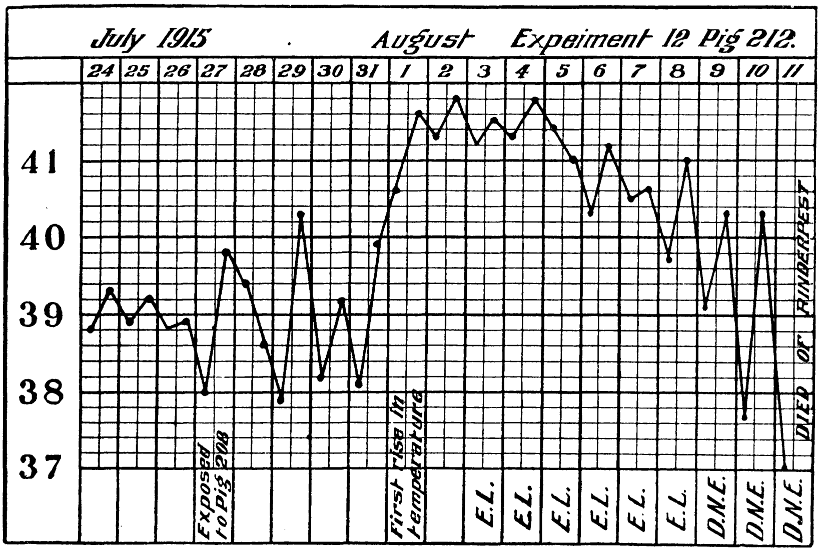

CHART II. Pig exposed to pig.

on account of being unthrifty, under normal conditions in the Philippines, this animal undoubtedly would have been allowed to live.

In comparing the percentage of mortality in pigs exposed to pigs sick with rinderpest with that of pigs exposed to cattle sick with rinderpest, it appears that the virulence of the disease is increased for pigs by being passed through a pig.

RINDERPEST TRANSMITTED FROM PIG TO PIG BY MEANS OF THE CARETAKER.

EXPERIMENT 14.

Pig 214.—Known history prior to the experiment. This animal was a native pig, 8 months old, purchased in Manila, and

kept in quarantine thirty-one days before it was used. At no time during this period did it have a high temperature or show any symptoms of sickness.

August 21, 1915, pig 214 was placed in corral No. 1. This experiment was designed to determine the following: (1) Whether the virus of rinderpest was still alive in such a form as to give the disease to a susceptible pig when placed in the corral, since a pig had died of rinderpest in this corral ten days previous (this was in line with previous experiments which have been performed at the laboratory on cattle and carabao (5), in which it was proved that the virus of rinderpest was in such a condition that it was unable to cause the disease after a corral had been freed from sick animals for twenty-four hours); and (2) whether the virus of hog cholera was present in the corral, since a pig which had died eleven days previous in this corral showed lesions of hog cholera simultaneous with lesions of rinderpest.

Before the completion of the experiment on pig 214 in this corral, added evidence was obtained on two other points: (1) The possibility of a pig contracting rinderpest after surviving hog cholera; and (2) the possibility of transmitting, by means of the caretaker, the virus of rinderpest from a pig sick with that disease to a susceptible pig.

History of corral No. 1 immediately previous to placing pig 214 therein:

On August 11, which was eleven days previous to the beginning of this experiment, pig 212 (experiment 12) had died of rinderpest in this corral; this animal also showed lesions of hog cholera.

On August 12, which was ten days previous to the beginning of this experiment, pig 208 (experiment 3) had died of rinderpest in this corral; this animal also showed lesions of hog cholera.

August 25, 1915, pig 214 showed a rise in temperature. Its p. m. temperature remained high, ranging between 40° and 40.8° C. until September 15, when it gradually subsided to normal. During this time although the animal did not develop diarrhea or show marked inappetence it was unthrifty and had a mucopurulent discharge from its eyes, presenting symptoms of a mild attack of hog cholera.

October 5, 1915, pig 216 (experiment 26) was placed in corral No. 2. This corral was approximately fifty yards from corral No. 1, in which pig 214 was kept at that time. Pig 216 was on its second day of temperature, D., N. E. on this date, and it died of rinderpest on October 6.

Pig 218 (experiment 13) developed its first rise of temperature on October 9, and died of rinderpest four days later. These two animals were cared for by the same man that took care of pig 214 in corral No. 1.

October 14, 1915, pig 214 developed a p. m. temperature of 40.5° C. This was nine days after pig 216 was placed in corral No. 2 and eight days after its death, and five days after the initial rise in temperature of pig 218, which was also kept in corral No. 2.

October 16–18, N. E.

October 18, died of rinderpest, showing typical lesions of that disease upon autopsy.

In summing up the results of experiment 14 it will be noted that pig 214 did not contract rinderpest in corral No. 1 which had contained a pig that died of rinderpest ten days previous to the admission of pig 214 to the corral. It will also be noted that pig 214 did have a temperature and showed mild symptoms of hog cholera, which it possibly contracted in corral no. 1. It will be noted also that the pig 214 did finally contract rinderpest and died of that disease, and that the disease was undoubtedly brought to it by means of the caretaker.

Also it will be noted that a pig can suffer from an apparent mild attack of hog cholera and recover from that disease, and later contract rinderpest and die.

PIGS INOCULATED WITH VIRULENT BLOOD FROM PIGS SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of pigs contracting rinderpest by inoculating them with blood taken from pigs sick with rinderpest. The animals which were inoculated were kept in screened stalls in a shed which was free from disease, until they developed a rise in temperature, at which time they were removed.

EXPERIMENT 15.

Pig 206.—Known history prior to the experiment. This animal was a native pig, 6 months old, purchased in Manila on May 28, 1915, and placed in quarantine.

May 29, 1915, pig 206 was inoculated with 10 cubic centimeters of virulent blood from pig 185.

History of pig 185 at the time the virulent blood was drawn from it:

May 29: Fourth day of temperature, N. E. The a. m. temperature was 39.4° C.; p. m. temperature, 40.1° C. For complete history see experiment 1.

June 2, pig 206 developed a rise in temperature, p. m., 40.2° C.; this was four days after inoculation.

June 3, this animal died. Autopsy did not reveal any marked lesions.

EXPERIMENT 16.

Pig 219.—Known history prior to the experiment. This animal was a native pig, 9 months old, purchased in Manila, and kept in quarantine forty-five days before it was used, and at no time during this period did it have a high temperature or show any symptoms of sickness.

October 5, 1915, pig 219 was inoculated with 2 cubic centimeters of virulent blood from pig 215.

History of pig 215 at the time the virulent blood was drawn from it:
October 5: Second day after the initial rise in temperature, a. m. temperature 39.1° C., p. m. temperature 40.7° C. For complete history see experiment 4.

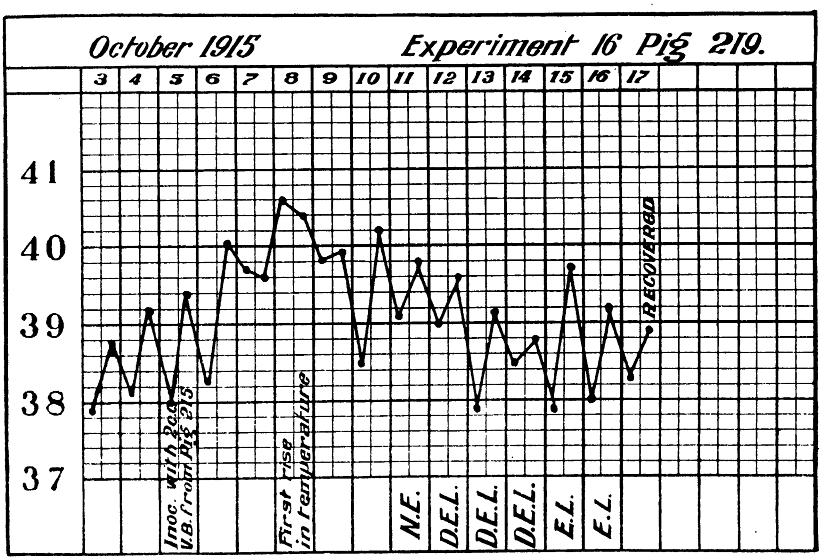

CHART III. Pig inoculated with blood from pig.

October 8, pig 219 presented a rise in temperature, a. m., 40.6° C.; p. m., 40.4° C.; this was three days after the inoculation.

October 11, N. E.

October 12–14, D., N. E.

October 15–16, E. L.

This animal gradually recovered but did not become thrifty and was killed December 4, 1915.

In summing up the results of experiments 15 and 16, it can not be stated with certainty that pig 206 used in experiment 15 contracted rinderpest, on account of its early death and the absence of lesions which are to be expected in the early stage

of the disease and which have been found in cattle and carabaos under similar conditions. However, the animal had an incubation period which corresponded to that of rinderpest.

In experiment 16, pig 219 ran a typical course of rinderpest and recovered with the after effects of being unthrifty, which condition is frequently noticed in pigs after they have recovered from rinderpest.

PIGS INOCULATED WITH VIRULENT BLOOD FROM CATTLE SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of pigs contracting rinderpest by inoculating them with blood taken from cattle sick with rinderpest. The animals which were inoculated were kept in screened stalls in a shed which was free from disease, until they developed a rise in temperature, at which time they were removed.

EXPERIMENT 17.

Pig 216.—Known history prior to the experiment. This animal was a native pig, 7 months old, purchased in Manila, and kept in quarantine seventy-two days before it was used. At no time during this period did it develop a temperature or show any symptoms of disease.

September 30, 1915, pig 216 was inoculated with 6 cubic centimeters of virulent blood from bull 3925, which was on its second day of temperature.

History of bull 3925:

September 25: inoculated with 200 cubic centimeters of virulent blood from bull 3937.

September 28: First rise in temperature, p. m., 40.4° C.

September 30: Second day of temperature, blood was taken to inoculate pig 216.

October 1–3: D., N. E.

October 3: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

October 3, pig 216 developed a rise in temperature, registering, a. m., 40.5° C.; p. m., 41.1° C.; this was three days after the inoculation.

October 5, D., N. E., and vomiting.

October 6, died of rinderpest, presenting marked lesions of that disease upon autopsy. This pig was used in exposure experiments 13 and 26.

EXPERIMENT 18.

Pig 241.—Known history prior to the experiment. This animal was a native pig six months old, purchased in Manila and kept in quarantine one hundred and fifteen days before it was used. It developed a high temperature on October 26, 1915, and was taken out of the quarantine shed and isolated. It developed a diarrhea on October 28, which lasted until November 7, when its diarrhea subsided and its temperature gradually returned to normal. During this period the animal presented a clinical picture of a mild case of hog cholera. November 26, pig 241 was returned to the quarantine shed, where it remained until it was used, and did not show a rise of temperature or any symptoms of sickness.

February 7, 1916, pig 241 was inoculated with 25 cubic centimeters of virulent rinderpest blood drawn from bull 3962, which was on its third day of temperature. Pig 241 was placed in a screened stall in a shed free from rinderpest.

History of bull 3962:

February 1, 1916: Bull 3962 was inoculated with 100 cubic centimeters of virulent rinderpest blood from bull 3960.

February 4: Bull 3962 developed a rise in temperature registering, a. m., 39.8° C.; p. m., 40.6° C.

February 5–8: D., N. E.

February 8: This animal presented a subnormal a. m. temperature of 35.8° C., and died, presenting typical lesions of rinderpest upon autopsy.

On the day the blood was drawn to inoculate into pig 241, this bull had diarrhea and was not eating.

February 10, pig 241 developed a rise in temperature, registering, a. m., 40° C.; p. m., 41.3° C.; this was the third day after inoculation.

February 13, N. E.

Pig 241 died during the night of February 13 and presented typical lesions of rinderpest upon autopsy.

EXPERIMENT 19.

Pig 239.—Known history prior to the experiment. This animal was a native pig, 8 months old, purchased in Manila, and kept under observation one hundred and twenty-two days before it was used. It developed a high temperature on October 27, 1915, and was taken out of the quarantine shed and isolated. It developed a diarrhea on October 28, which continued until November 7, at which time the diarrhea subsided

and the temperature returned to normal. During this period the animal presented a clinical picture of suffering from a mild attack of hog cholera. November 26, pig 239 was returned to the quarantine shed, where it remained until it was used, and did not develop a rise in temperature or show any symptoms of sickness during this period.

February 14, 1916, pig 239 was inoculated with 20 cubic centimeters of blood from bull 3993 which had been bled to death February 13, for virulent blood to be used in immunization work. The blood which was inoculated in the pig had been kept 24 hours in the ice box.

History of bull 3993 from which the blood was taken:

February 5, 1916: Drenched with 100 cubic centimeters of urine from pig 242 (experiment 35).

February 9: First rise of temperature, registering, p. m., 40.5° C.

February 12–13: E. L.

February 13: Bled to death for virulent blood to be used in immunizing work.

Pig 239 did not develop a rise in temperature or show any symptoms of sickness from this injection and afterwards was exposed in shed No. 3, where the animals sick with rinderpest were kept, and continued to give the same negative results.

EXPERIMENT 20.

Pig 154.—Known history prior to the experiment. This animal was a Berkshire, about 1 year old; it was brought to the laboratory from the Bureau of Agriculture experiment station at Alabang on October 13, 1915, and was kept in quarantine at the laboratory one hundred and thirty-two days before it was used. During this period the animal did not show a rise in temperature. On January 10–11, 1916, it had diarrhea, which was undoubtedly due to dietetic conditions.

February 23, 1916, pig 154 was inoculated with 8 cubic centimeters of blood from cow 3995 which had been bled to death on February 21 for virulent blood to be used in immunization work. The blood which was inoculated into pig 154 had been kept 48 hours in the ice box.

History of cow 3995 from which the blood was taken:

February 11, 1916: This animal was exposed to pig 241 (experiment 28).

February 17: First rise in temperature, registering, p. m., 40.2° C.

February 20: D., E. L.

February 21: D., N. E. On this date it was bled to death for virulent blood to be used in immunization work.

Pig 154 did not develop a rise in temperature or show any symptoms of sickness from this injection. It was later exposed in shed No. 3 where animals sick with rinderpest were kept, and it continued to give the same negative results.

In summing up the results of experiments 17, 18, 19 and 20 it will be noted that the pigs used in experiments 17 and 18 had an incubation period of three days and ran a severe course of the disease and died, presenting typical lesions of rinderpest upon autopsy.

Both of the pigs used in experiments 19 and 20 ran a high

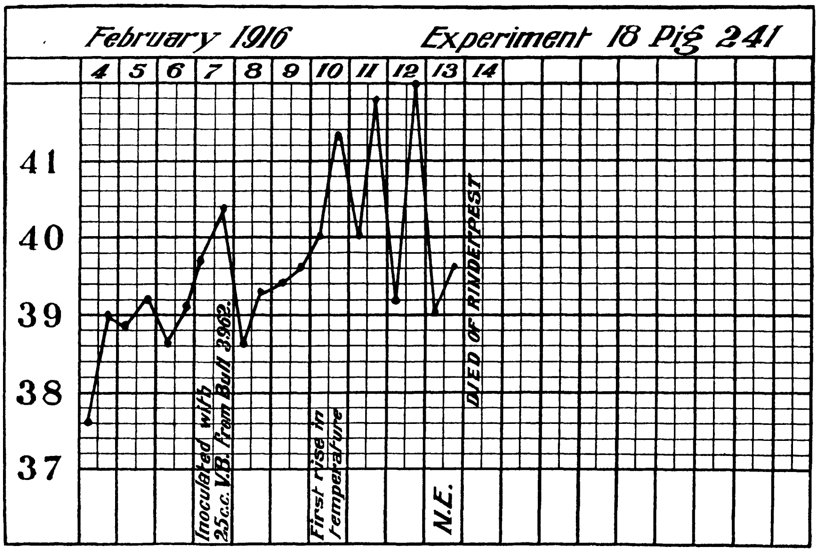

CHART IV. Pig inoculated with blood from bull.

temperature and developed diarrhea previous to being used in these experiments. At the time they were sick it was thought they were suffering from hog cholera; however, it is possible that they were suffering from a mild form of rinderpest, as it is almost impossible to distinguish the two diseases in pigs unless autopsy is made or their blood is inoculated into susceptible cattle. These animals did not contract rinderpest when inoculated with virulent blood from cattle and they did not contract rinderpest by subsequent exposures.

The blood they were injected with was proved to be virulent as in both cases it was used in immunizing work with good results.

Hence pigs 239 and 154 were either naturally immune to

rinderpest or they had suffered from a previous attack of rinderpest and had acquired immunity.

PIGS INOCULATED WITH VIRULENT BLOOD FROM CATTLE AND PIGS SICK WITH RINDERPEST.

The following experiment was designed to furnish information regarding the possibility of pigs contracting rinderpest when inoculated with a mixture of virulent rinderpest blood from cattle and pigs.

EXPERIMENT 21.

Pig 244.—Known history prior to the experiment. This animal was a native pig, 6 months old, purchased in Manila, and kept in quarantine seventy-eight days before it was used. At no time during this period did it have a high temperature or show any symptoms of sickness.

January 4, 1916, pig 244 was inoculated with a mixture of 25 cubic centimeters of virulent rinderpest blood from bull 3976 and pig 237.

History of bull 3976 from which blood was taken:

December 28, 1915: Bull 3976 was inoculated with 100 cubic centimeters of virulent rinderpest blood procured from a sick carabao in Pampanga Province.

December 31: First rise in temperature, registering, a. m., 39.1° C.

January 3, 1916: Bled to death for virulent blood to be used in immunizing work.

(For history of pig 237 from which blood was taken, see experiment 9.)

January 7, pig 244 developed a rise in temperature, registering, a. m., 39.8° C.; p. m., 40.6° C.; this was three days after the inoculation.

January 10, this animal's p. m. temperature was 41.3° C., which was the highest temperature registered during the course of the disease.

January 10–24, D., E. L.

January 24, died of rinderpest, presenting good lesions of that disease upon autopsy.

In summing up the results of this experiment it will be noted that a pig will contract rinderpest when inoculated with a mixture of virulent rinderpest blood from cattle and pigs.

PIGS DRENCHED WITH VIRULENT BLOOD FROM CARABAOS SICK WITH RINDERPEST

The following experiment was designed to furnish information regarding the possibility of pigs contracting rinderpest, when given virulent rinderpest blood from carabaos by drench.

EXPERIMENT 22.

Pig 243.—Known history prior to the experiment. This animal was a native pig, 6 months old, purchased in Manila and kept in quarantine ninety-two days before it was used. At no time during this period did it register a high temperature. On January 10 and 11, it had diarrhea which immediately subsided and was undoubtedly due to dietetic conditions.

January 18, 1916, pig 243 was drenched with 50 cubic centimeters of virulent rinderpest blood, procured from a carabao sick with rinderpest from Pampanga Province.

January 22, pig 243 presented a rise in temperature, registering, p. m., 40.2° C.; this was four days after it had received the drench.

January 23, a. m. temperature 41.0° C.

January 24, bled to death for virulent blood to be used in immunization work.

In summing up the results of this experiment it will be noted that a pig will contract rinderpest when drenched with virulent rinderpest blood taken from a carabao sick with rinderpest.

CATTLE EXPOSED TO PIGS SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of cattle contracting rinderpest when exposed to pigs sick with rinderpest.

The experiments were conducted in corrals Nos. 1 and 2 and in stall No. 1.

The cattle used in these experiments were obtained from Batan Island. As, to our knowledge, there has never been any rinderpest on this island, these cattle are highly susceptible.

EXPERIMENT 23.

Bull 3908.—Known history prior to the experiment. Native Batanes bull, 5 years old, received at the laboratory and placed in quarantine March 13, 1915. This animal was kept under observation seventy-four days before it was used and at no time during this period did it present a high temperature or develop any symptoms of sickness.

May 26, 1915, bull 3908 was placed in corral No. 1 with pig 185, which was on its second day of temperature (see experiment 1), and the exposure was continued for fifteen days.

May 30, bull 3908 was also in contact with pig 186, first day of temperature (see experiment 11), and the exposure was continued for twelve days.

(For history of pigs 185 and 186 see experiments 1 and 11.)

Bull 3908 did not develop any symptoms from these exposures.

June 10, bull 3908 was inoculated with 200 cubic centimeters of virulent rinderpest blood from bull 3840 (see experiment 29).

June 17, first rise in temperature, registering, p. m., 39.3° C., which was the highest temperature during the course of the disease; this was seven days after the inoculation.

June 15–20, D. It will be noted that the animal had a diarrhea three days before its slight rise in temperature.

June 21–25, D., N. E.

June 26–July 3, D., E. L.

July 4, died of rinderpest, presenting good lesions of that disease upon autopsy.

EXPERIMENT 24.

Bull 3924.—Known history prior to the experiment. Native Batanes bull, 3 years old, received at the laboratory and placed in quarantine April 13, 1915. This animal was kept under observation seventy days before it was used, and at no time during this period did it present a high temperature or show any symptoms of sickness.

June 22, 1915, bull 3924 was exposed in corral No. 1 to pig 207, which was on the second day of its temperature (see experiment 2). This exposure was continued twenty-two days.

History of pig 207 (see experiment 2):

June 22: p. m. temperature 40.8° C.
June 23: p. m. temperature 40.9° C.
June 24: p. m. temperature 41.2° C.
June 25: p. m. temperature 40.8° C.
June 30–July 2: D.
This animal gradually recovered, but never became thrifty.

Bull 3924 did not show a rise in temperature or present any symptoms of sickness during this exposure.

July 3, bull 3924 was inoculated with 100 cubic centimeters of virulent rinderpest blood taken from a carabao in Imus.

July 8, inoculated with 10 cubic centimeters of virulent rinderpest blood from bull 3930.

July 11, bull 3924 presented a p. m. temperature of 40° C. This was the highest and only rise in temperature this animal showed.

July 17, inoculated with 5 cubic centimeters of blood taken from bull 3929, which showed anaplasma in its blood.

July 21–22, D.

September 13–14, D.

September 17, died, the cause of death not being ascertained.

EXPERIMENT 25.

Bull 3935.—Known history prior to the experiment. Native Batanes bull, 2 years old, received at the laboratory and placed in quarantine June 16, 1915. This animal was kept under observation forty-one days before it was used and at no time during this period did it present a high temperature or show any symptoms of sickness.

July 27, 1915, bull 3935 was exposed in corral No. 1 to pig 208, which was on its fifth day of temperature. This exposure was continued for sixteen days. This bull was also exposed on August 1 to pig 212 on the first day of temperature. This exposure was continued for eleven days.

History of pig 208 (see experiment 3):
- July 27: It presented an a. m. temperature of 39.5° C. and a p. m. temperature of 41.2° C.
- July 31–August 7: E. L.
- August 3: It presented a p. m. temperature of 41.6° C., which was the highest temperature registered during the course of the disease.
- August 8–11: D., E. L.
- August 12: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of pig 212 (see experiment 12):
- August 1: a. m. temperature 40.6° C.; p. m. temperature 41.6° C.
- August 3–7: E. L.
- August 9–11: D., N. E.
- August 11: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

Bull 3935 did not show a rise in temperature or develop any symptoms of sickness from these two exposures.

September 16, 1915, bull 3935 was inoculated with 100 cubic centimeters of virulent rinderpest blood procured from a sick carabao in Pampanga Province.

September 20, bull 3935 presented an a. m. temperature of 39.6° C., and was bled to death for virulent blood to be used in immunization work.

EXPERIMENT 26.

Bull 3886.—Known history prior to the experiment. Native Batanes bull, 3 years old, received at the laboratory and placed in quarantine November 7, 1914. This animal was kept under observation three hundred and thirty-two days before it was used in this experiment and at no time during this period did it have a high temperature or show any symptoms of sickness.

It had been used in two previous experiments which were as follows:

February 19, 1915, inoculated with 10 cubic centimeters of virulent rinderpest blood which had been heated at 58° C. in a water bath for one hour.

The animal did not develop any reaction from this.

August 28, 1915, this animal was inoculated with a culture made from rinderpest blood.

The animal did not develop any reaction from this.

October 5, 1915, bull 3886 was exposed in corral No. 2 to pig 216 which was on the second day of temperature. This exposure lasted one day. This bull was also exposed on October 9 to pig 218, which was on the first day of temperature. This exposure was continued for nine days.

This bull was also exposed by means of the caretaker on October 13, to pig 214. This exposure was continued for five days.

History of pig 216 (see experiment 17):
- October 5: D., N. E., and vomiting.
- October 6: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of pig 218 (see experiment 13):
- October 9: First rise in temperature, registering, a. m., 40.4° C.; p. m., 41.6° C.
- October 11–12: E. L.
- October 13: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of pig 214 (see experiment 14):
- October 14: First rise in temperature.
- October 16–18: N. E.
- October 18: Died of rinderpest, showing typical lesions of that disease upon autopsy.

October 20, bull 3886 developed a rise in temperature, registering, p. m., 40.2° C.

October 25–26, N. E.

October 27–30, D., N. E.

October 31–November 7, D., E. L.

November 7–11, D., N. E.

November 12, died of rinderpest, presenting typical lesions of that disease upon autopsy.

EXPERIMENT 27.

Bull 3979.—Known history prior to the experiment. Native Batanes bull, 1 year and four months old, received at the laboratory and placed in quarantine October 23, 1915. This animal was kept under observation thirty-four days before it was used, and at no time during this period did it have a high temperature or show any symptoms of sickness.

November 26, 1915, bull 3979 was exposed four days in stall No. 2 to pig 240, which was on its third day of temperature.

> History of pig 240 (see experiment 7):
> November 26: N. E. Temperature, p. m. 40.8° C.
> November 27–28: D., N. E.
> November 29: E. L.
> This animal gradually recovered but later contracted hog cholera.

Bull 3979 presented no reaction to this exposure.

December 9, 1915, bull 3979 was inoculated with 150 cubic centimeters of V. B. from bull 3963.

December 12, first rise in temperature.

December 13–14, N. E.

December 14, bled to death for V. B. to be used in immunization work.

EXPERIMENT 28.

Cow 3995.—Known history prior to the experiment. Native Batanes cow, 13 years old, received at the laboratory and placed in quarantine January 19, 1916. This animal was kept under observation twenty-three days before it was used, and at no time during this period did it have a high temperature or show any symptoms of sickness.

February 11, 1916, cow 3995 was exposed for four days in stall No. 2 to pig 241, which at the time of the exposure was on its second day of temperature.

> History of pig 241 (see experiment 18):
> February 11: a. m. temperature 40° C.; p. m. temperature 41.8° C.
> February 12: a. m. temperature 39.2° C.; p. m. temperature 42° C.
> February 13: N. E.
> Pig 241 died during the night of February 13 and presented typical lesions of rinderpest upon autopsy.

February 17, cow 3995 presented a rise in temperature, registering, p. m., 40.2° C.

February 18, a. m. temperature 39.2° C.; p. m., 40.7° C.

February 20, D., E. L.

February 21, D., N. E., bled to death for virulent blood to be used in immunization work.

In summing up the results obtained in experiments 23 to 28, inclusive, it will be noted that cattle can contract rinderpest from pigs by being exposed by contact in a corral or stall, to pigs sick with rinderpest, although the transmission of the disease does not appear to be so constant as by other methods; the reason for this has not as yet been ascertained.

In experiment 23, it will be noted that bull 3908 and pig 186

(experiment 11) were exposed in the same corral and at the same time to pig 185 and that pig 186 contracted the disease but the bull was unaffected. It will also be noted that bull 3840 (experiment 29) was inoculated with blood from pig 185 on May 27, and contracted rinderpest from this blood, which proves that the blood of pig 185 was virulent when bull 3908 was exposed to it. It will also be noted that bull 3908 was exposed to pig 186 through the entire course of the disease including the incubation period, and bull 3908 remained unaffected. Finally it will be noted that bull 3908 was inoculated with virulent rinderpest blood which was taken from bull 3840 and that bull 3908

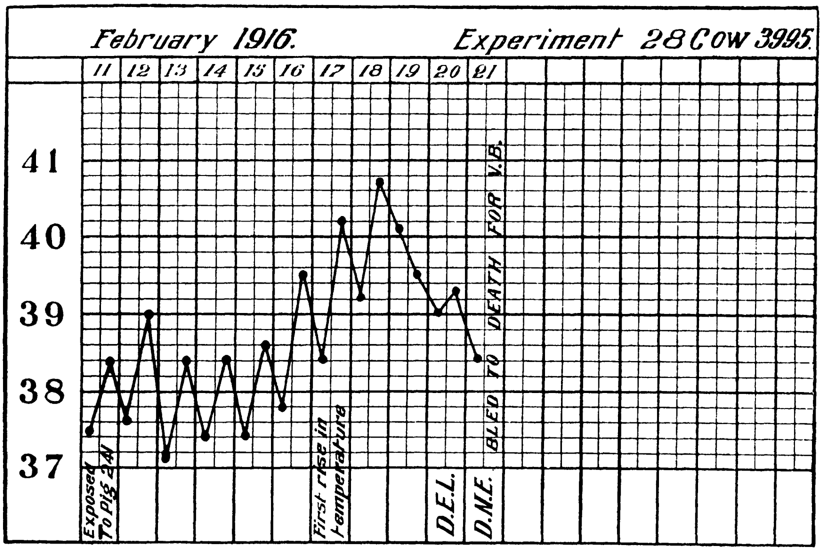

CHART V. Bull exposed to pig.

contracted rinderpest from this inoculation and died. Thus by inoculation, bull 3908 was killed with the same virus to which it had been exposed in pig 185 without effect.

In experiment 24, bull 3924 was either naturally immune to rinderpest, a condition of rare occurrence, or it contracted a very mild type of disease from the exposure to pig 207 and thereby developed an active immunity, since it was unaffected by subsequent inoculations of virulent rinderpest blood.

In experiment 25 it will be noted that bull 3935 and pig 212 (experiment 12) were exposed in the same corral and at the same time to pig 208, and that pig 212 contracted the disease but bull 3935 remained unaffected. It will also be noted that bull 3935 was exposed to pig 212 through the entire course of

the disease, including the incubation period, and that the bull remained unaffected. When this animal was inoculated with virulent blood, however, it contracted rinderpest, which proves that it was susceptible during the exposures, but for some unknown reason failed to contract rinderpest by contact with the pigs.

In experiment 26, bull 3886 did contract rinderpest and die of that disease by being exposed to pigs sick with rinderpest, which proves that it is possible for cattle to contract rinderpest by being exposed to pigs sick with that disease.

Experiment 28 gives proof similar to that of experiment 26, showing that it is possible for cattle to contract rinderpest from pigs by exposure.

CATTLE INOCULATED WITH BLOOD FROM PIGS SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of cattle contracting rinderpest when inoculated with blood from pigs which were sick with that disease.

The cattle used in these experiments were of a similar type to those used in the preceding experiments.

EXPERIMENT 29.

Bull 3840.—Known history prior to the experiment. Native Batanes bull, 4½ years old, received at the laboratory, and placed in quarantine September 28, 1914. This animal was kept under observation two hundred and forty-one days before it was used in this experiment.

On October 6, 1914, this animal was inoculated with 50 cubic centimeters of blood taken from a sick animal at Calamba. Bull 3840 did not present any reaction to this inoculation.

On October 18, 19, and 20, this animal presented p. m. temperatures of 39.9°, 40°, and 39.9° C., respectively. At no other time during this period of observation did it present a high temperature, and at no time did it show any symptoms of sickness.

May 27, 1915, bull 3840 was inoculated with 20 cubic centimeters of virulent blood from pig 185.

(For history of pig 185, see experiment 1.)

May 30, bull 3840 presented a rise in temperature, registering, p. m., 40° C.

June 5–6, N. E.

June 7–9, D., E. L.

This animal gradually recovered, and was later used in making hyperimmune rinderpest serum.

August 19, bull 3840 received subcutaneously 1,000 cubic centimeters of virulent rinderpest blood from bull 3928. This injection caused a slight rise in temperature on the following day but the animal suffered no other disturbance.

September 20, bull 3840 received subcutaneously 1,000 cubic centimeters of virulent rinderpest blood from bull 3935. This injection caused practically no reaction.

EXPERIMENT 30.

Bull 3937.—Known history prior to the experiment. Native Batanes bull, 4 years 9 months old, received at the laboratory, and placed in quarantine June 16, 1915. This animal was kept under observation forty-eight days before it was used, and at no time during this period did it have a high temperature or show any symptoms of sickness.

August 3, 1915, bull 3937 was inoculated with 0.5 cubic centimeter of blood from pig 212.

History of pig 212 (see experiment 12):
August 3: E. L.

Bull 3937 presented no reaction to this inoculation.

September 20, bull 3937 was inoculated with 100 cubic centimeters of virulent rinderpest blood from bull 3935.

September 23, rise in temperature.

September 26–27, D., N. E.

September 27, died of rinderpest presenting typical lesions of that disease upon autopsy.

EXPERIMENT 31.

Bull 3839.—Known history prior to the experiment. Native Batanes bull, 4 years old, received at the laboratory, and placed in quarantine September 28, 1914. This animal was kept under observation three hundred and seventy-two days before it was used in this experiment.

October 10, 1914, this animal presented a p. m. temperature of 40° C. and was isolated from the quarantine shed.

October 11, D.

Otober 12, D., E. L.

October 18, this animal was returned to the quarantine shed as its temperature and physical appearance were normal. The temperature and diarrhea were undoubtedly due to dietary conditions.

May 4, 1915, this animal developed a diarrhea which lasted but one day.

May 21, 22 and 23, this animal again developed a diarrhea but did not present a high temperature and soon returned to normal.

August 24, 1915, bull 3839 was inoculated with a culture in an experiment on the cultivation of the rinderpest virus, but the animal failed to show any reaction to this inoculation.

October 5, 1915, bull 3839 was inoculated with 3 cubic centimeters of virulent rinderpest blood from pig 216.

History of pig 216 (see experiment 17):

October 5: D., N. E., vomiting.

October 6: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

October 9, bull 3839 presented an a. m. temperature of 39.8° C.

October 12, 13 and 14, D., N. E.

October 15, died of rinderpest, presenting typical lesions of that disease upon autopsy.

EXPERIMENT 32.

Cow 3958.—Known history prior to the experiment. Native Batanes cow, 2 years old, received at the laboratory, and placed in quarantine October 1, 1915. This animal was kept under observation ten days before it was used.

October 5, D. The animal did not possess a temperature, however, and the bowels were normal the following day.

October 10, 1915, cow 3958 was inoculated with 50 cubic centimeters of virulent rinderpest blood from pig 217.

History of pig 217:

Contracted disease by exposure to sick pigs.

October 8: First rise in temperature, registering, a. m., 39.7° C.; p. m., 41° C.

October 11: D., E. L.

October 14, cow 3958 presented an a. m. temperature of 39.3° C.; p. m., 40.4° C.

This animal showed a high temperature until October 22, when its temperature subsided to normal. It did not develop inappetence or diarrhea during the course of the disease and was proved immune by subsequent exposures in the shed where the animals sick with rinderpest were kept.

In summing up the results obtained in experiments 29 to 32, inclusive, it will be noted that cattle readily contract rinderpest when inoculated with blood taken from pigs sick with that disease.

In experiment 30 the bull failed to contract the disease when inoculated with 0.5 cubic centimeter of blood. Although this is a very small amount yet such a quantity is usually sufficient to give the disease, and a much smaller quantity has been demonstrated to transfer the disease when the virulent blood was taken from a sick bull (6).

In experiment 32, cow 3958 was inoculated with blood from pig 217 to ascertain whether the pig had contracted rinderpest or hog cholera in the quarantine shed, the result showing that the pig did contract rinderpest.

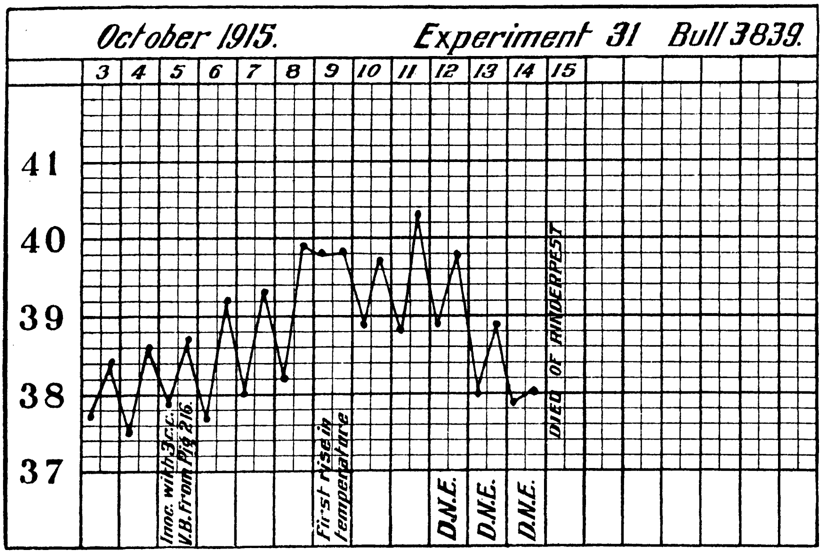

CHART VI. Bull inoculated with blood from pig.

CATTLE INOCULATED WITH A MIXTURE OF BLOOD FROM PIGS AND CATTLE SICK WITH RINDERPEST.

The following experiment was designed to furnish information regarding the possibility of cattle contracting rinderpest when inoculated with a mixture of blood from pigs and cattle sick with rinderpest, as it was desired in several instances to obtain more blood for immunization work than would be furnished by one bull. Thus if the virus maintained its potency by mixing pig and cattle blood, pigs could frequently be bled to death to supply the demand.

EXPERIMENT 33.

Cow 3987.—Known history prior to the experiment. Native Batanes cow, 1 year and 2 months old, received at the laboratory, and placed in quarantine October 23, 1915. This animal

was kept under observation forty-three days before it was used in this experiment.

December 31, 1915, D.

January 1, 1916, D.

January 2–3, D., E. L. This condition was undoubtedly due to dietary conditions as the animal did not present a high temperature.

January 4, cow 3987 was inoculated with 150 cubic centimeters of mixed V. B. from pig 237 and bull 3976.

(For history of pig 237, see experiment 9.)

(For history of bull 3976, see experiment 21).

January 7, cow 3987 presented an a. m. temperature of 39.1° C. and a p. m. temperature of 40.4° C.

January 9, E. L.

January 10, E. L., bled to death for virulent blood to be used in immunization work.

In summing up the results of this experiment it will be noted that the potency of the virulent blood is not materially affected by mixing pig and cattle blood.

CATTLE DRENCHED WITH URINE FROM PIGS SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of cattle contracting rinderpest from the urine of pigs suffering with rinderpest.

EXPERIMENT 34.

Cow 3978.—Known history prior to the experiment. Native Batanes bull, 2 years old, received at the laboratory, and placed in quarantine October 23, 1915, and kept under observation fifty-two days before it was used. During this period it did not present a high temperature or show any symptoms of sickness.

December 14, 1915, bull 3978 was drenched with 30 cubic centimeters of urine from pig 155. Water was added to the urine making the quantity 250 cubic centimeters. This urine had also stood over night.

History of pig 155 (see experiment 8):

December 14, a. m. temperature 40.2° C.; p. m. temperature, 40.6° C.

This animal ran a mild course of the disease and did not develop inappetence or diarrhea.

Bull 3978 did not develop any reaction to this drench.

January 18, 1915, bull 3978 was inoculated with 400 cubic

centimeters of virulent rinderpest blood procured from a carabao sick with rinderpest in Pampanga Province.

January 22, bull 3978 presented a rise in temperature.

January 24, this animal was bled to death for V. B. to be used in immunization work.

EXPERIMENT 35.

Bull 3993.—Known history prior to experiment. Native Batanes bull, 7 years old, received at the laboratory, and placed in quarantine January 19, 1916, and kept under observation sixteen days before it was used in this experiment. At no time

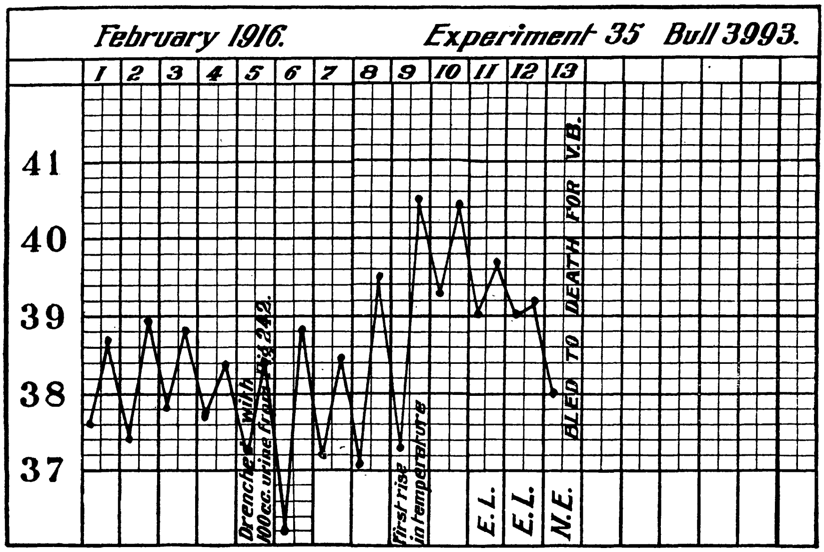

CHART VII. Bull drenched with urine from pig.

during this period did it have a high temperature or show any symptoms of disease.

February 5, 1916, bull 3993 was drenched with 100 cubic centimeters of fresh undiluted urine from pig 242.

History of pig 242 (see experiment 10):
- February 5: E. L.; a. m. and p. m. temperatures 40.4° C.
- February 6: N. E.
- February 7: Died of rinderpest, presenting typical lessions of that disease upon autopsy.

February 9, bull 3993 presented a p. m. temperature of 40.5° C.

February 12 and 13, E. L.

February 13, N. E., and was bled to death for virulent blood to be used in immunization work.

In summing up the results of these two experiments, with special reference to experiment 35, it will be noted that cattle can contract rinderpest by being drenched with urine from a pig sick with rinderpest. In experiment 34 there is a possibility that the urine was kept too long before using as has been demonstrated in previous work (4).

CARABAOS EXPOSED TO PIGS SICK WITH RINDERPEST.

The following experiment was designed to furnish information regarding the possibility of carabaos contracting rinderpest by being placed in contact with pigs sick with rinderpest. This experiment was conducted in stall No. 2.

EXPERIMENT 36.

Carabao 57.—Known history prior to the experiment. This animal was a native carabao from Aparri, 8 years old, received at the laboratory, and placed in quarantine May 11, 1916, and kept under observation seventy-two days before it was used in this experiment.

June 17, 1916, carabao 57 was used in an experiment in which an investigation was being conducted by the writer and Dr. H. W. Wade of the Bureau of Science to try and produce a vaccine for rinderpest by attenuating the virus by means of desiccating virulent blood and tissue pulp. This investigation will be reported on at a later date.

Carabao 57 gave no reaction to the injections administered.

July 22, 1916, carabao 57 was exposed to pigs 299 and 301.

History of pig 299:
- July 17, 1916: Inoculated with 50 cubic centimeters of virulent blood from carabao 53.
- July 20: First rise in temperature.
- July 21–23: N. E.
- July 24: E. L.
- July 25–26: D. E. L.
- July 27: Died of rinderpest, presenting typical lesions of that disease upon autopsy.

History of pig 301:
- July 17, 1916: Inoculated with 50 cubic centimeters of virulent rinderpest blood from carabao 53.
- July 19: First rise in temperature.
- July 21–23: N. E.
- July 24–27: E. L.
- This animal gradually recovered.

July 29, carabao 57 presented a rise in temperature, registering, a. m., 39.3° C.

July 31, D., N. E.

August 1–2, D., N. E.

August 3, died of rinderpest, presenting typical lessions of that disease upon autopsy.

In summing up the results of this experiment, it is proved that a carabao can contract rinderpest from pigs sick with that disease when the carabao is exposed to the pigs by direct contact.

CARABAOS INOCULATED WITH BLOOD FROM PIGS SICK WITH RINDERPEST.

The following experiment was designed to furnish information regarding the possibility of carabaos contracting rinderpest

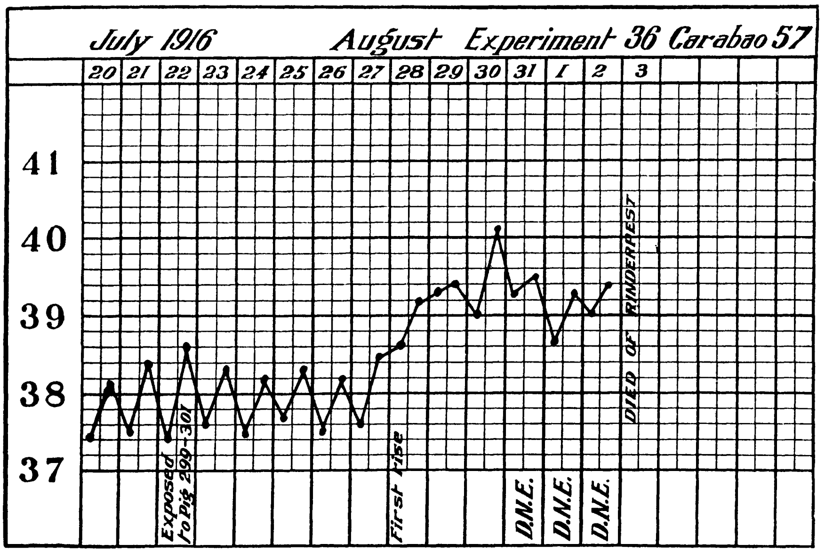

CHART VIII. Carabao exposed to pig.

from pigs when inoculated with blood from pigs sick with rinderpest.

EXPERIMENT 37.

Carabao 51.—Known history prior to the experiment. This animal was a native carabao from Aparri, 6 years old; it was received at the laboratory and placed in quarantine May 11, 1916, and was kept under observation thirty-three days before it was used in this experiment.

May 26, 1916, carabao 51 was used in an experiment on vaccination against rinderpest by the injection of desiccated virulent blood, but gave no reaction.

At no time during the period of observation did this animal present a high temperature or show any symptoms of sickness.

June 13, 1916, carabao 51 was inoculated with 10 cubic centimeters of blood from pig 300.

History of pig 300.

June 4, 1916: Inoculated with 10 cubic centimeters of virulent rinderpest blood procured from a carabao in Angono, Rizal Province.

June 9: First rise in temperature, registering, a. m., 39.2° C.; p. m., 40° C.

June 13: E. L.; bled to death, at which time the blood was procured to inject carabao 51.

June 19, carabao 51 presented a rise in temperature, registering, a. m., 39.8° C.; p. m., 40.7° C.

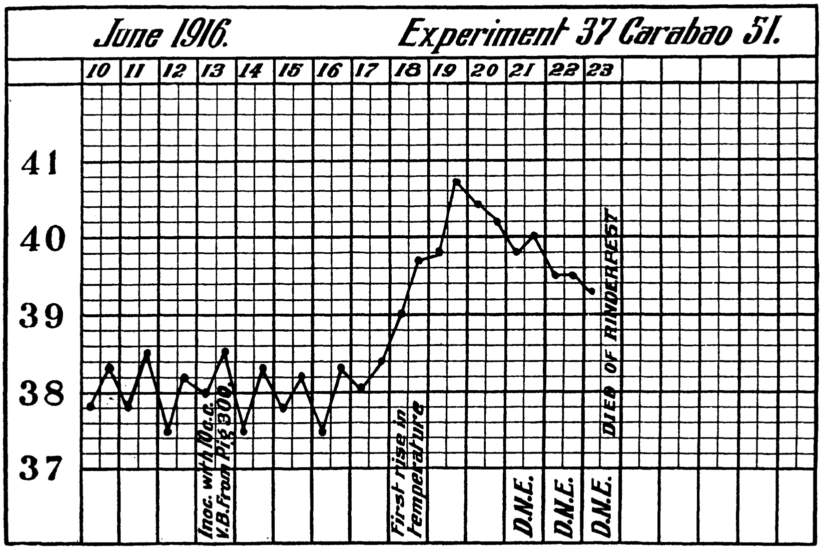

CHART IX. Carabao inoculated with blood from pig.

June 21, 22, 23 D., N. E.

June 23, died of rinderpest, presenting good lesions of that disease upon autopsy.

In summing up the results of this experiment it will be noted that carabaos will contract rinderpest when injected with blood from pigs sick with rinderpest.

PIGS INOCULATED WITH BLOOD FROM CARABAOS SICK WITH RINDERPEST.

The following experiments were designed to furnish information regarding the possibility of pigs contracting rinderpest when inoculated with virulent rinderpest blood from a carabao suffering with that disease.

EXPERIMENT 38.

Pig 299.—Known history prior to the experiment. Native pig, 8 months old, purchased in Cavite Province in a locality which was free from rinderpest; it was brought to the laboratory and placed in quarantine May 30, 1916, and was kept under observation forty-eight days before it was used in this experiment.

June 2, E. L. This condition was caused undoubtedly on account of change in feed as the animal did not present a high temperature or show any other symptoms of sickness during this period.

July 17, 1916, pig 299 was inoculated with 50 cubic centimeters of virulent rinderpest blood from carabao 53.

History of carabao 53:

July 1, 1916: Inoculated with 1.2 grams of dried virulent blood from carabao 54. This blood was dried in twenty hours and then kept in the ice box in a sealed tube for twenty-two hours.

June 10: First rise in temperature.

June 15: D., E. L.

June 16–19: D., N. E.

June 20: Died of rinderpest, presenting good lesions of that disease upon autopsy.

July 20, pig 299 developed a rise in temperature, registering, a. m., 39.2° C.; p. m., 40.2° C.

July 21–23, N. E.

July 24, E. L.

July 25–26, D., E. L.

July 27, died of rinderpest, presenting good lesions of that disease on autopsy.

EXPERIMENT 39.

Pig 301.—Known history prior to the experiment. Native pig, 7 months old, purchased in Cavite Province, brought to the laboratory, and placed in quarantine May 30, 1916, and kept under observation forty-eight days before it was used in this experiment.

June 2, 3, and 4, this animal suffered from dietary disturbances but immediately returned to normal. At no other time during this period did this animal present any symptoms of sickness.

July 17, 1916, pig 301 was inoculated with 50 cubic centimeters of virulent rinderpest blood from carabao 53.

(For history of carabao 53 see experiment 38.)

July 19, pig 301 developed a rise in temperature, registering, p. m., 40.3° C.

July 21–23, N. E.
July 24–27, E. L.
This animal gradually recovered.

In summing up the results of these two experiments it will be noted that pigs will contract rinderpest when inoculated with virulent rinderpest blood from a carabao.

RINDERPEST TRANSMITTED FROM CATTLE TO PIGS BY MEANS OF THE CARETAKER.

This experiment was designed to furnish information regarding the possibility of transmitting rinderpest from cattle sick

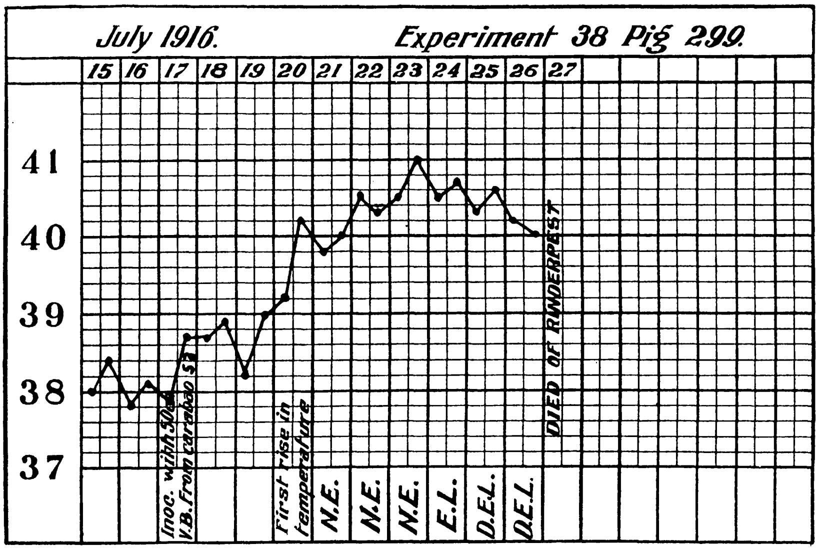

CHART X. Pig inoculated with blood from carabao.

with rinderpest to pigs by means of the caretaker. The sick cattle and the susceptible pigs were cared for by the same man.

EXPERIMENT 40.

On March 13, 1916, pigs 270, 271, 269, and 273 were placed in separate stalls in the same shed where cattle sick with rinderpest were kept. These pigs were not kept in quarantine previous to their exposure and did not come in direct contact with the sick cattle but were cared for by the same man who took care of the sick cattle.

March 21, 1916, pig 270, native, three months old, presented a rise in temperature, registering, p. m., 39.6° C.; this was eight days after the initial exposure.

March 26, D.

March 27–28, D., E. L.

March 28, died of rinderpest, presenting good lesions of that disease upon autopsy.

Pig 271, native, 5 months old, presented a rise of temperature March 28, 1916; this was fifteen days after the initial exposure. Its temperature on this day registered, p. m., 40.4° C.

April 3–5, N. E.

April 6, E. L.

April 7–8, N. E.

April 9, died of rinderpest, presenting good lesions of that disease upon autopsy.

Pig 269, native, three months old, presented a rise of temperature March 28, 1916; this was fifteen days after the initial exposure. Its temperature on this day registered, p. m., 40.3° C.

March 31, D.; a. m. temperature 40.4° C.; p. m. temperature 41.6° C.; this was the highest temperature recorded during the course of the disease.

April 1, 1916, D.

April 2, found dead in the morning. Presented good lesions of rinderpest upon autopsy.

Pig 273, native, seven months old, presented a rise in temperature March 28, 1916, registering, p. m., 40.1° C.; this was fifteen days after the initial exposure.

April 3–5, E. L.

April 6–7, D., E. L.

April 8–9, D., N. E.

April 10, D.

This animal gradually recovered.

In summing up the results of the exposure of these four pigs it will be noted that pigs can contract rinderpest from cattle sick with that disease by means of the caretaker.

PIGS RECOVERED FROM RINDERPEST, AND THIS IMMUNITY TESTED TOWARD THAT DISEASE.

The following experiment was designed to test the immunity of pigs to rinderpest after they had recovered from that disease. These animals were kept in the shed where the animals sick with rinderpest were placed, which gave them frequent exposures to animals sick with rinderpest in all stages of the disease.

EXPERIMENT 41.

In this experiment pigs 94, 266, 267, 289, 291, 297, 301, 302, 155, and 154 were used.

Pig 94.—This animal was a Berkshire sow and had been

hyperimmunized to hog-cholera virus, and was later exposed to rinderpest by contact and contracted and ran a mild course of the disease, recovering on December 5, 1914.

This animal was again exposed to rinderpest January 23, 1915, and these exposures have been continued up to date, covering a period of six hundred sixty-five days. During this time the pig has not shown any ill effects from these exposures, there having been no temperature or physical reaction.

Pig 266.—Recovered from rinderpest March 24, 1916. This animal was kept in the shed one hundred sixty days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 267 recovered from rinderpest April 2, 1916. This animal was kept in the shed one hundred fifty-one days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 289 recovered from rinderpest May 20, 1916. This animal was kept in the shed one hundred three days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 291 recovered from rinderpest May 13, 1916. This animal was kept in the shed one hundred ten days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 297, recovered from rinderpest June 28, 1916. This animal was kept in the shed sixty-four days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 301 recovered from rinderpest July 28, 1916. This animal was kept in the shed thirty-three days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 302 recovered from rinderpest June 8, 1916. This animal was kept in the shed eighty-four days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 155 recovered from rinderpest December 21, 1915. This animal was kept in the shed two hundred and fifty-four days with animals sick with rinderpest and did not develop any ill effects from these exposures.

Pig 154.—Inoculated with 8 cubic centimeters of virulent rinderpest blood from bull 3995 on February 22, 1916. This animal did not react and was kept in the shed 191 days with

animals sick with rinderpest and did not develop any ill effects from these exposures.

In summing up the results of the exposures of the ten preceding pigs, it will be noted that there is apparently a permanent immunity conferred on them against rinderpest after recovering from that disease, or at least for practically two years, which is the average life of a hog used for food purposes.

PIGS RECOVERING FROM RINDERPEST AND LATER BECOMING INFECTED WITH HOG CHOLERA.

The following experiment was designed to furnish information as to whether pigs which had recovered from rinderpest were susceptible to hog cholera.

EXPERIMENT 42.

On May 15, 1916, pigs 293, 294, 295, and 296 were received at the laboratory and placed in quarantine.

May 17, these four animals developed symptoms which were later identified as those of hog cholera. On this date the four animals were transferred to shed No. 3 and placed in the same pen with pigs 265, 272, 273, and 292, which had recovered from rinderpest.

Pig 265 recovered from rinderpest March 22, 1916.

May 17, 1916, this animal was exposed to the four pigs sick with hog cholera; this was fifty-six days after it had recovered from rinderpest.

May 30, pig 265 presented a rise in temperature.

June 7–11, E. L.

June 12, died of hog cholera, presenting good lesions of that disease upon autopsy.

Pig 272 recovered from rinderpest April 10, 1916.

May 17, 1916, this animal was exposed to the four pigs sick with hog cholera; this was thirty-seven days after it had recovered from rinderpest.

May 30, pig 272 presented a rise in temperature.

June 10–16, E. L.

June 17–23, D., E. L.

June 23, died of hog cholera, presenting good lesions of that disease upon autopsy.

Pig 273 recovered from rinderpest April 11, 1916.

May 17, 1916, this animal was exposed to the four pigs sick with hog cholera; this was thirty-six days after it had recovered from rinderpest.

June 1, 1916, pig 273 presented a rise in temperature.

June 10–15, E. L.

June 16–19, N. E.

June 20, D., E. L.

June 21–23, E. L.

June 23, this animal was killed and upon autopsy presented good lesions of hog cholera.

Pig 292 recovered from rinderpest May 9, 1916.

May 17, 1916, this animal was exposed to the four pigs sick with hog cholera; this was eight days after it had recovered from rinderpest.

May 30, 1916, pig 292 presented a rise in temperature. This animal ran a mild course and was killed on June 23, and presented a few lesions of hog cholera upon autopsy.

From the results obtained in the preceding experiment it will be noted that pigs which have recovered from rinderpest are susceptible to and can die of hog cholera which proves that there is no immunity toward hog cholera conferred upon a pig which has recovered from rinderpest.

PIGS HYPERIMMUNIZED TO HOG CHOLERA AND LATER CONTRACTING RINDERPEST.

The following experiments were designed to ascertain whether pigs which had been hyperimmunized against hog cholera, would contract rinderpest when exposed to cattle sick with rinderpest.

EXPERIMENT 43.

Pig 1.—This animal received its last injection of 450 cubic centimeters of virulent hog-cholera blood on October 15, 1914.

November 16, 1914, pig 1 was exposed to bull 3845.

History of bull 3845:

November 9, 1914: Inoculated with 200 cubic centimeters of virulent blood from bull 3780.

November 11: Bull 3845 presented a rise in temperature.

November 11–16: D.

No. 17–18: D., N. E.

November 19: Died of rinderpest.

November 20, pig 1 presented a rise in temperature, registering, a. m. 39.8° C.; p. m., 41.9° C.

November 22–27, N. E.

November 28, E. L.

This animal's temperature gradually subsided to normal and it made a complete recovery.

EXPERIMENT 44.

Pig 2.—This animal received its last injection of 350 cubic centimeters of virulent hog-cholera blood on October 14, 1914.

November 9, 1914, pig 2 was exposed to bull 3780.

History of bull 3780:

November 21, 1914: Inoculated with 200 cubic centimeters of virulent rinderpest blood from bull 3838.
November 5: Bull 3780 presented a rise in temperature.
November 11: D., N. E.
November 12: E. L.
This animal gradually recovered.

November 13, pig 2 presented a rise in temperature, registering, a m., 40° C.; p. m., 40.3° C.

November 16, p. m. temperature 41.3° C.

This animal showed a high temperature until November 21, when it subsided to normal and the animal made a prompt recovery.

EXPERIMENT 45.

Pig 4.[1]—This animal received its last injection of 450 cubic centimeters of virulent hog-cholera blood on October 13, 1914.

December 1, 1914, pig 4 was exposed to bull 3847.

History of bull 3847:

November 28, 1914: Inoculated with 100 cubic centimeters of virulent rinderpest blood from bull 3873.
December 1: Bull 3847 presented a rise in temperature.
December 5–8: D., E. L.
December 9–10; D.
This animal gradually recovered.

December 8, pig 4 presented a p. m. temperature of 40.5° C.

December 9, p. m. temperature 41° C.

This animal showed a high temperature until December 15, when it subsided to normal and the pig recovered.

EXPERIMENT 46.

Pig 5.—This animal received its last injection of 400 cubic centimeters of virulent hog-cholera blood on October 14, 1914.

November 23, 1914, pig 5 was exposed to bull 3846.

History of bull 3846:

November 16, 1914: Inoculated with 100 cubic centimeters of virulent rinderpest blood from bulls 3716 and 3845.
November 19: Bull 3846 presented a rise in temperature.

[1] Pig No. 3 was not used in this series of experiments.

November 21: D., E. L.
November 22–23: D.
November 24–25: D., N. E.
November 26, died of rinderpest.

November 25, pig 5 presented a p. m. temperature of 41.1° C.

November 26–27, p. m. temperature 41.7° C.

November 28, N. E.

November 29, D., N. E.

November 30, E. L.

December 1, E. L.

This animal's temperature returned to normal December 6, and the pig recovered.

EXPERIMENT 47.

Pig 6.—This animal received its last injection of 300 cubic centimeters of virulent hog-cholera blood on October 14, 1914.

November 16, 1914, pig 6 was exposed to bull 3846.

(For history of bull 3846, see experiment 46.)

November 19, pig 6 presented an a. m. temperature of 39.7° C.; and a p. m. temperature of 41.7° C.

November 23–27, N. E.

November 28–30, E. L.

December 1, E. L.; this animal was killed on this date.

EXPERIMENT 48.

Pig 7.—This animal received its last injection of 450 cubic centimeters of virulent hog-cholera blood on October 15, 1914.

November 12, 1914, pig 7 was exposed to bull 3842.

History of bull 3842:
November 7, 1914: Inoculated with 100 cubic centimeters of virulent rinderpest blood from Pampanga Province.
November 13: Bull 3842 presented a rise in temperature.
This animal ran a rather mild form of the disease and recovered.

November 16, pig 7 presented an a. m. temperature of 39° C., and a p. m. temperature of 41.1° C.

November 17, p. m. temperature 41.2° C.

November 21, this animal's temperature had subsided to normal and the pig made a rapid recovery.

In summing up the results of these experiments it will be noted that pigs which have been hyperimmunized to hog cholera can contract rinderpest when exposed to cattle sick with rinderpest. These results prove that there is no immunity conferred against rinderpest by the hog-cholera virus, although the animals ran

a milder course of the disease than has been usually witnessed in the laboratory. This condition may be considered from two view points: First, that possibly the strain of rinderpest virus was not very virulent; and second, that the hyperimmunization against hog cholera may have increased the resistance toward rinderpest.

CONCLUSIONS.

1. From the results obtained in experiments 1 to 10, inclusive, it is proved that pigs can contract rinderpest when exposed to cattle sick with rinderpest. The disease thus contracted by pigs may terminate in death, unthriftiness or complete recovery.

2. From the results obtained in experiments 11 to 13, inclusive, it is proved that pigs can contract rinderpest when exposed to pigs sick with rinderpest.

3. From the results obtained in experiment 14 it is proved that a pig can contract rinderpest from pigs sick with rinderpest by means of the caretaker.

4. From the results obtained in experiments 15 and 16 it is proved that pigs can contract rinderpest when inoculated with blood drawn from pigs sick with rinderpest.

5. From the results obtained in experiments 17 to 20, inclusive, it is proved that pigs can contract rinderpest when inoculated with blood drawn from cattle sick with rinderpest.

6. From the results obtained in experiment 21 it is proved that a pig can contract rinderpest when inoculated with mixed blood drawn from cattle and pigs sick with rinderpest.

7. From the results obtained in experiment 22 it is proved that a pig can contract rinderpest when it is drenched with blood drawn from carabaos sick with rinderpest.

8. From the results obtained in experiments 23 to 28, inclusive, it is proved that cattle can contract rinderpest when exposed to pigs sick with rinderpest. However, cattle do not contract the disease very readily by this method and the exact reason for this has not been ascertained at the present writing.

9. From the results obtained in experiments 29 to 32, inclusive, it is proved that cattle can contract rinderpest when inoculated with blood drawn from pigs sick with rinderpest.

10. From the results obtained in experiment 33 it is proved that cattle can contract rinderpest when inoculated with mixed blood drawn from pigs and cattle sick with rinderpest.

11. From the results obtained in experiments 34 and 35 it is proved that cattle can contract rinderpest when drenched with urine collected from pigs sick with rinderpest.

12. From the results obtained in experiment 36 it is proved that carabaos can contract rinderpest when exposed to pigs sick with rinderpest.

13. From the results obtained in experiment 37 it is proved that carabaos can contract rinderpest when inoculated with blood from pigs sick with rinderpest.

14. From the results obtained in experiments 38 and 39 it is proved that pigs can contract rinderpest when inoculated with blood from carabaos sick with rinderpest.

15. From the results obtained in experiment 40 it is proved that pigs can contract rinderpest from cattle sick with rinderpest by means of the caretaker.

16. From the results obtained in experiment 41 it is proved that pigs remain immune to rinderpest after their recovery from that disease for at least 665 days and undoubtedly during the rest of their existence.

17. From the results obtained in experiment 42 it is proved that pigs which have recovered from rinderpest are susceptible to and may die from hog cholera, which shows that there is no immunity against hog cholera conferred upon a pig which has passed through an attack of rinderpest.

18. From the results obtained in experiments 43 to 48, inclusive, it is proved that pigs which have been hyperimmunized to hog cholera are susceptible to rinderpest when exposed to cattle sick with rinderpest. Although the pigs used in these experiments did not run as severe a course of the disease as the average pig, there is a possibility that the strain of virus with which they were infected was not of the most virulent type. This condition is frequently noticed in rinderpest in cattle. One strain may cause a high mortality while another may cause a comparatively low mortality. Thus it is rather difficult to state definitely that the hyperimmunization to hog cholera was of any benefit to the pigs when they were exposed to rinderpest.

19. In summing up the results of all of these experiments it will be noted that cattle, carabaos and pigs vary but slightly in susceptibility to rinderpest, and that the disease can be transmitted practically as readily from one type of animal to the other, as among their individual kind.

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SHIELD BUDDING OF COFFEE.

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

Coffee plantations are to an almost exclusive degree planted to seedlings. On this basis the coffee industry has assumed such enormous proportions that seedling plantations are taken as a matter of course, and the need of vegetative propagation of coffee has probably never occurred to most of those financially interested in this industry. It was also somewhat of a surprise to the writer, during a visit to the coffee districts in Java last year, to find a considerable acreage planted to grafted trees and quite extensive plantations in the making that were being set out to such trees. In this the Dutch are decidedly ahead of the coffee planters in other parts of the world, and it is rather remarkable that no mention has been made in the English-speaking agricultural publications of this progress in coffee culture in the Tropics, considering that the matter has been discussed in well illustrated papers in agricultural publications in Java.

As stated in the last issue of this REVIEW, the grafting operation in Java consists of a cleft graft on young stock about the thickness of a lead pencil. The graft, instead of being waxed, is covered by a glass tube to exclude water. (Pl. XII, *c*.) The work is usually performed by native labor and a good percentage of live grafts are obtained.

With those who are familiar with coffee and the process of grafting, it is scarcely necessary to call attention to the fact that from a given number of scions twice as many buds may be obtained as grafts—a fact in connection with coffee which is worthy of more than ordinary attention when we recall that *grafted trees with normal habit are obtainable only when scions are taken from stems or the vertical growths of the suckers,* scions from the horizontal branches producing plants of dwarf and spreading habit. It follows that the increase of grafted plants from a single tree is necessarily very slow during several years.

Experimentation in budding and grafting coffee was so much in line with other work at Lamao that it was immediately

started on the return of the writer from Java, a large number of robusta coffee plants having just reached the proper size for the work.

In the course of this work, which was started in November, 1915, and continued until June, 1916, petioled cleft grafts have been made, and in the shield budding both petioled and non-petioled budwood in various stages of maturity has been experimented with. Waxed tape has been used exclusively in tying, and the exposed cut of the scions in the cleft graft carefully waxed. No glass tubes were used to protect the scions from the entrance of water.

The net results of the work indicate that in the case of cleft grafting the use of waxed tape and wax to hermetically exclude air and water from the wounds in stock and scion is a decided improvement upon the use of unwaxed tying material supplemented by a glass tube covering the graft. The scion should be inserted in the stock preferably not more than 10 centimeters above the ground.

Shield budding is of course simpler than the grafting operation and can be performed more rapidly. Good success has been obtained by using well matured, green, non-petioled budwood with buds 3.5 to 4 centimeters long; the age and appearance of the stock at the point of insertion of the bud is apparently unimportant; the buds should be entirely covered with waxed tape.

Plates XI and XII illustrate the methods described above, and grafted and budded plants obtained in the experiments.

In Java, Liberian, Excelsa, Abeocuta and related coffees are considered to be the best stocks.

CANE-JUICE CLARIFICATION.

By Cleve. W. Hines, M. S., *Sugar Technologist.*

There is no operation in the manufacture of sugar which demands greater attention than the clarification of the crude liquors since the grade of sugar which may be made is determined largely by the efficiency of this work. The main reason why it is possible to make a high-grade sugar in the refinery is because of the very rigid clarification and bleaching of the juice by the animal char or boneblack filters.

The importance of employing the most effective clarifying reagents for each class of liquor cannot be overestimated regardless of the grade of sugar it is desired to make, since the higher the purity of the liquor for concentration the greater will ordinarily be the recovery of finished sugar and the less molasses will consequently result. In addition to the above-named advantage from using a highly clarified juice for concentration, there will be less heat required to boil the sugar and less work required in the subsequent processes of its extraction.

The selection of a clarifying reagent best suited to the particular liquor is a subject to which each sugar manufacturer should give much attention. This requires the conducting of experiments using the different reagents under varied conditions.

In order to carry on this work successfully a good sugar laboratory is indispensable where not only purity coefficient and glucose ratio are determined but also the ash content of the juices must be ascertained in order to determine the quantity of the inorganic reagent left in the juice. This latter determination is important since an excess of certain of the basic compounds contained in some clarifying reagent often causes the finished sugar to be more hygroscopic while also there may be later a darking of the sugar due to the subsequent oxydation of these compounds. This point is of special importance when a plantation-white or granulated sugar is being made. In order to determine the relative efficiency of the various clarifying reagents on the juices of sugar cane of different stages of maturity extensive experiments were conducted with the various clarify-

ing reagents during the past year. These results will be referred to later in this article. It was observed that the composition of the impurities which was determined by the stage of maturity of the cane had a very noticeable effect upon the action of the different reagents. Not only were different quantities of the reagents required to give the same result with the various classes of juices but also a substitution of certain of the reagents was necessary to obtain maximum results when treating the juices from slightly green, mature, and over-mature cane grown in the same locality and under identical conditions.

LIME.

The most common of all cane-juice clarifying agents is lime, or calcium oxide. This was the only clarifying substance used in early times and in the manufacture of the lower grades of sugar forms the only reagent generally employed today. The sole purpose of adding lime to cane juice is to effect the removal of the natural impurities contained in the juice and neutralize the excess of organic acid. It is imperative that only high-grade calcium rock be used in the production of the lime since many of the impurities therein contained may pass on to the finished lime. These are more or less soluble in the cane juice and may not only lower the coefficient of purity but they may also cause a coating of the evaporator tubes which in turn causes a lower heat transmission. Another disadvantage occasioned by certain of the inorganic salts which finally reach the finished sugar is that they are hygroscopic and cause the sugar to absorb water, or they may become oxydized and turn dark, thus lowering the quality of the finished product.

According to the well known authority on sugar manufacture, Dr. Princen Geerligs, the maximum percentages of impurities contained in lime for use in clarifying cane juices should not exceed the following:

	Per cent.
Magnesium	2.0
Iron and aluminum	2.0
Silica	2.0
Water	2.0
Carbonic acid	2.0
Sulphuric acid [1]	.5

The trouble caused by iron salts especially when in combination with one of the polyphenols forming the dark-colored tannate of iron is becoming more apparent as greater attention is given

[1] Cane sugar and its manufacture.

to the manufacture of plantation-white sugar. It is therefore to be expected that the prejudice against the use of lime containing an excess of iron will continue to grow.

The quality of the lime found on the market today is largely determined by three factors: By the quality of the original calcium-carbonate rock used in producing the lime; by the care with which the lime was burned; and by the effectiveness with which the lime was kept from the air while in the containers. It matters not whether the crude rock was secured from sea shells, marble, or the softer forms of stratified calcium deposits, the portions containing an excess of the impurities may usually be detected by the color and thus an opportunity is given for the selection of the purer portions of the rock. This is a point often neglected by manufacturers of lime since it necessitates more workmen and naturally entails greater expense.

In the burning of the lime alternate layers of coke or coal and the lime rock are placed in the kiln. An intense heat is produced during the burning of this and unless proper attention is given to the work there is danger of local superheating which impairs the quality of the finished product. This is more especially the case when there is an excess of impurities present in the lime rock.

The importance of protecting the lime from the air while in the containers should not be overlooked since the presence of damp air will cause the lime to absorb moisture and pass to the hydroxide form and this will later take on carbon dioxide causing it to revert back to the calcium-carbonate or inactive state. While the carbonate would not be considered a troublesome impurity but on the contrary it might even be beneficial to a certain extent in acting as a mechanical precipitant, yet the effectiveness of the lime as a chemical reagent is thus greatly impaired.

Lime performs several very important functions in the clarification of cane juice. Its first purpose is to neutralize the acids present. It then combines with various organic compounds such as albumins, albuminoids, pectin bodies, etc. The lime further combines with the inorganic constituents of the juice including the phosphates, sulphates, and carbonates, thus forming the heavier precipitate which passes to the bottom of the settling tanks and at the same time brings down suspended impurities. This latter effect, though purely mechanical, is extremely beneficial in cane-juice clarification and is often greatly accelerated by insoluble compounds consisting of particles of earth brought in with the cane before crushing.

It has been found that cane grown in regions containing large quantities of light silicious dust and harvested just after a violent storm which caused more or less of the silty material to adhere to the stalks thereby reaching the cane carrier, yielded juice which settled better than the juice from the cane which had first been thoroughly washed. The above juice gives a slight rise in purity when subjected to single clarification for test sugar. This improvement in clarification was attributed to the mechanical effect of the silicious dust but in order to prove conclusively that the dust was responsible for this result the organic matter was burned out of a sample of the silty dust from one of the above regions. This inorganic matter was then sifted and that which passed through a 75-mesh sieve was used in the test.

The juice was limed to litmus neutrality in the ordinary manner and one portion was immediately heated to the boiling point after which the blanket of light impurities which rose to the top was removed by skimming. The juice was then left to settle for twenty minutes. The other portion was treated with 1 per cent of the fine silty dust after which it was heated to the boiling point and allowed to settle as in the previous case. In addition to a slightly resulting rise in the purity of the juice treated by the silty dust, it required less lime for the complete precipitation of the impurities.

THE SACCHARATE METHOD.

This method instead of precipitating the impurities in order to facilitate their removal as was done in the above system, performs the opposite function as it causes the sucrose to combine with the lime which is later precipitated and separated from the impure liquor by filtration.

Among the various chemical compounds commercially employed for this purpose may be mentioned barium, strontium, and calcium oxides.

Of the three above-named reagents the calcium oxide is the one most generally employed. This forms three saccharates, as follows:

Monobasic saccharate	$C_{12}H_{22}O_{11}CaO$
Dibasic saccharate	$C_{12}H_{22}O_{11}(CaO)_2$
Tribasic saccharate	$C_{12}H_{22}O_{11}(CaO)_3$

The monobasic saccharate is quite soluble in water, while the dibasic saccharate is soluble in warm water but insoluble in the cold and in that state it crystallizes out quite easily. When

solutions containing sucrose and lime, or even the monobasic and dibasic saccharate, are heated to the boiling point the tribasic saccharate is found which is but slightly soluble in water.

This latter saccharate may also be found in solutions at a lower temperature provided the lime is made to combine directly with the sucrose while yet in the oxide form. This is the system followed in the so-called Steffens method used in beet-sugar manufacture. In this case the unslaked lime is ground to a fine powder and added to the sugary solution from time to time while the temperature of the solution is maintained at 12 to 20° C. by the aid of cooling tubes arranged in the tanks. During this treatment the solution is thoroughly agitated in order to bring the lime into intimate contact with the sucrose.

Heat of chemical action is produced when the lime is added in the oxide form and were not a low temperature maintained the lime would combine with water forming the hydroxide instead of the saccharate.

By careful manipulation and with the proper temperature maintained it is possible to precipitate practically all of the sucrose in the solution.

The crystallized tribasic saccharate is then filtered off by the aid of ordinary filter presses, and washed in the same manner as is done with the cake of impurities in the cane-sugar industry. The washed precipitate is then placed in tall tanks, and the sucrose is liberated by a carbonitation process which precipitates the calcium as calcium carbonate. The solution is again passed through the filter presses this time the filter consisting of the impurity (calcium carbonate) while the filtrate containing the sucrose is in a fairly pure state and ready for concentration.

While the above process answers very well with beet-sugar products in which there is only a small percentage of the reducing sugars present it would not answer for cane-sugar products on account of there being an excessive amount of these compounds to contend with. A modification of the saccharate process was devised to Mr. Battelle of Hawaii which answers very well for cane-sugar products and gives a higher rendiment of the sucrose than was possible with any of the other systems.

It was formerly thought that there would be very disastrous results should an alkaline cane juice or molasses in which there was a high percentage of reducing sugars present, be heated to a high temperature. This assumption was based on the fact that the glucose was broken up by the high alkalinity which caused dark-colored decomposition products to form. In the modified system the sucrose itself is precipitated and separated from the

impure solution, consequently the color of the impure liquor is of little or no importance.

Experiments were conducted here on cane juices containing from 0.5 to 1.5 per cent of reducing sugars in which calcium hydroxide was used as the tempering agent. It was observed that when the juice was limed to litmus neutrality the best clarifying results were obtained with both the single and double carbonitation processes. When it was limed to phenolphthalein neutrality and heated to a high temperature a slight darkening resulted. As more lime was added the color continued to grow darker until the maximum amount was reached which was determined by the percentage of the reducing sugars present. Once these dark-colored impurities were formed there was no satisfactory manner in which they could be effectively removed except by careful filtration through boneblack. When, however, the sucrose was combined with lime, forming tribasic saccharate, it was possible to filter the crystals from the dark-colored liquor and after careful washing these were decomposed by carbon dioxide giving a juice which was sufficiently clear to produce a good sugar without further treatment.

The alkaline clarification gave poor results not only on account of the dark-colored decomposition products which were formed but also on account of the breaking up of certain albuminous compounds by the high alkalinity which were first precipitated with a consequent lowering of purity.

SULPHUR DIOXIDE.

While this reagent is extensively used in the factories making the better grades of sugar its value lies more in its property of bleaching some of the nonsugars present, rather than in that of removing impurities.

The sulphur-dioxide gas is generally produced directly in the the cane-sugar factory by burning the sulphur in a specially constructed stove. On account of the formation of sulphuric acid when sulphur dioxide combines with water while at a high temperature, carefully constructed coolers must be arranged to prevent the gases from reaching the juice until the temperature is properly reduced.

Experiments with sulphuring the juice both before and after the addition of lime indicated that no particular rise in purity resulted from the sulphur-dioxide treatment of the juice from ripe cane, but when it was applied to the juice from overripe cane after liming to litmus neutrality, a slight rise was observed.

Sulphur dioxide exerts a sterilizing effect on the juice which serves as a useful disinfectant when the factory is shut down for a time, but when the juice is heated to 95° C. or over, as is generally done after the application of the lime, there is no particular benefit derived in this respect since the juice is made sterile by the heat.

The main benefit derived from this reagent lies in its bleaching effect. When applied to the juice which has previously been treated with lime but which still contains many of the natural impurities of the cane, it exerts a reducing effect on these substances and greatly improves the color. During the heating of the juice the sulphites are gradually changed into sulphates and it is during this process that the principal part of the discoloration takes place.

In order to accomplish this bleaching effect of the impurities with less trouble than was experienced with sulphurous acid the so-called hydrosulphites of calcium and sodium came into use. The latter has proved to be the more satisfactory of the two since it is a dry powder and does not deteriorate so readily as the calcium form. The sodium form now commonly used in the sugar industry is sold under the trade name of "Blanket" and has the formula $Na_2S_2O_4$. When this compound comes in contact with moisture as in its application to cane juice it is decomposed according to the following formula: $Na_2S_2O_4+H_2O+O_2=NaHSO_3NaHSO_4$. This reagent has the additional advantage over sulphurous acid of being applicable to alkaline as well as to acid solutions. While sugar-house products bleached with the sulphites often reassume the original dark color when left exposed to the air and light yet the condition of the product treated with this sodium-hydrosulphite determines to a great extent the permanence of the bleaching effect. When alkaline juices were treated the effect was seen to be much more permanent than when the acid condition was maintained.

PHOSPHORIC ACID.

The various compounds of phosphorus including the monocalcium, dicalcium, and tricalcium phosphates, sodium phosphate, etc., are used only as precipitating reagents and exert no bleaching effect whatever on the juice. Their principal use lies in their power to precipitate the excess of calcium left in the juice while at the same time many of the suspended impurities are brought to the bottom of the subsiders. The juice usually assumes a clearer and brighter appearance after treatment with

lime and any one of the various compounds of the acid, which often indicates that it had been bleached. This is especially true when the juice had been previously boiled in iron vessels which causes small quantities of the iron to be combined with the polyphenols or tannates.

The juice from slightly immature cane when boiled in iron containers darkened remarkably due to the formation of tannates of iron but when this juice was boiled in copper vessels there was no darkening effect produced. Experiments on these juices with various quantities of phosphoric acid in addition to the lime indicated that the color could be greatly improved but it was not entirely removed by this treatment. The quantity of the phosphoric compound required to give maximum results was largely determined by the amount of uncombined lime left in the juice.

The addition of 0.5 to 1 per cent of infusorial earth or "Kieselguhr" to the juice greatly accelerated the precipitation of the impurities and caused a precipitate to form which was easily filtered through cloth. On account of the colloidal, gelatinous-like material collecting on the particles of the silicious compounds a larger percentage of this material was removed before the juice was filtered, consequently it was possible to use the filter presses for a much longer time than was possible with the untreated juice. The juice from overmature cane which contained an excess of the colloidal bodies was especially benefited by treatment with this reagent.

Further experiments were conducted with a compound known as "phospho-gelose" which is a combination of phosphoric acid and "Kieselguhr." This reagent usually contains from 25 to 50 per cent of phosphoric acid, and is made by absorbing the acid with the silicious compound. The sample of this material used in the above experiments contained 28 per cent of free acid.

The best method of using this reagent was to lime to litmus neutrality, heat the juice to the boiling point, treat it with enough of the "phospho-gelose" to bring the acidity to 10 c. c. against N/28 alkali using phenolphthalein as an indicator. The juice was again heated to the boiling point and subsided, this operation requiring from fifteen to twenty-five minutes. Equally as good results were obtained by applying enough of the free acid to bring the acidity to the point indicated above and having the Kieselguhr added just before the juice was heated the second time.

Another compound with which experiments were conducted is known as "Sanso Clarifier."

Analysis of this reagent by the Bureau of Science showed the following composition:

	Per cent.
Phosphoric anhydride (P_2O_5)	39.43
Calcium	6.87
Sulphur	1.58
Residue insoluble in H Cl	0.19
Loss on ignition	16.00
Moisture	36.00
Acidity 1 gram	9.38 c. c. $N/_1$

It was found that practically the same results might be obtained with this reagent as with phosphoric acid when a sufficient quantity was employed to precipitate the excess of calcium left in the juice and bring it to the same acidic condition. On account of the low content of phosphoric acid more of this reagent was necessary than of the other compounds.

TALITE.

This is a white crystalline powder containing, according to an analysis by the Bureau of Science, 32.8 per cent of fluosilicate of sodium. This reagent was used singly and in combination with various other reagents including calcium oxide, phosphoric acid, sulphurous acid, sodium and calcium sulphite, and diatonatious earth, but no perceptible improvement was observed from its use. In some cases the juice showed a slight decrease in purity due to the addition of this reagent which could not be easily removed later.

NOTES ON A FATAL PARASITIC INFESTATION IN A HERD OF CATTLE AND GOATS IN THE PROVINCE OF AMBOS CAMARINES.

By WILLIAM HUTCHINS BOYNTON, *Pathologist, Bureau of Agriculture,* and LAWRENCE D. WHARTON, *Asst. Professor of Zoölogy, University of the Philippines.*

In January, 1916, Dr. W. H. Boynton was sent to the Province of Ambos Camarines to investigate the cause of the death of a large number of animals on a plantation near the town of Minalabag. These animals were kept for breeding purposes in a large pasture, a part of which was composed of high land and a part low rice-paddy land.

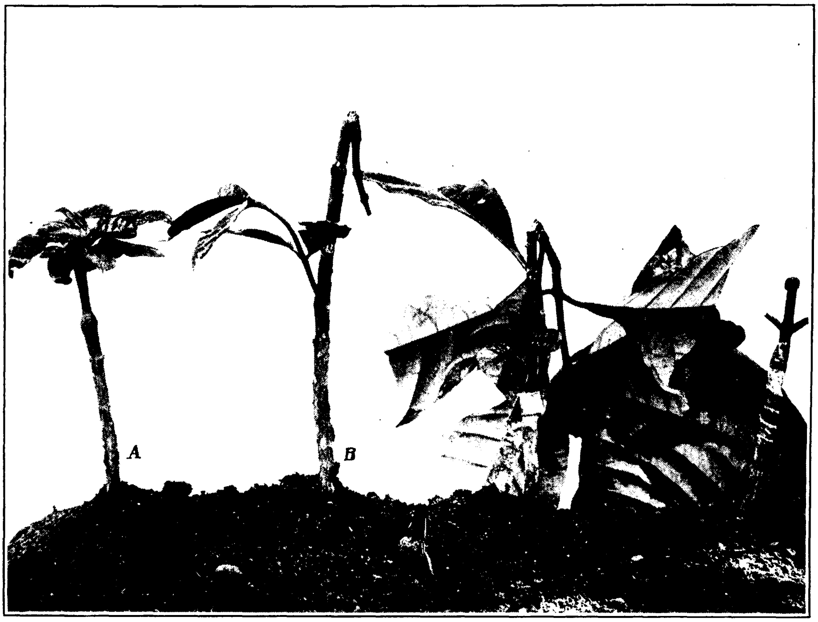
The herd was composed of 90 animals immunized by the simultaneous method against rinderpest on March 1, 1915, and 55 animals which had not been immunized against rinderpest.

The animals which were not immunized were brought from the Island of Masbate and arrived at the plantation on September 20, 1915. The immunized and the non-immune animals were kept together.

The owner of the cattle maintained a strict quarantine against outside animals as there was rinderpest in some of the neighboring districts and he was afraid the nonimmune animals would contract the disease. Every evening the cattle were placed under cover and smudges were burned around this inclosure during the night to keep off mosquitoes which are very plentiful in that locality. The animals received an abundance of green feed from the low pasture land. On account of the precautions taken against rinderpest infection, both in having a large number of immunized animals and in quarantining against outside animals, and also on account of the care which the animals received, it was expected that they would thrive.

Practically all the animals were in good condition when they arrived at the plantation, but it was noticed that after a time even with the feed and care which they received a large number began to get thin and, as the caretaker states, they kept getting thinner and thinner and finally died, although they ate well until just before death.

A considerable number died during and just after the heavy



(*a*) Graftage of coffee. A, Cleft-grafted plant a few weeks after grafting; B and C, shield-budded plants showing sprouting buds; D, a newly cleft-grafted plant. Lamao experiment station, 1916.

(*b*) Graftage of coffee. A and B, shield-budded plants about three weeks after the insertion of the buds, illustrating methods of lopping; C, section of shield-budded plant showing method of wrapping the bud. Lamao experiment station, 1916.

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PLATE XII.

(a) Graftage of coffee. Shield-budded plant of Robusta coffee. Lamao experiment station, 1916.

(b) Cleft-grafted plant of Robusta coffee. Lamao experiment station, 1916.

(a) Cleft-grating of coffee in Java, illustrating the method employed to prevent the entrance of extraneous moisture to the point of union by means of glass tubes placed over the grafts.

Courtesy of the Department of Agriculture, Buitenzorg, Java.

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storms, which indicated that they did not have vitality enough to withstand these storms.

There were also 60 head of goats on the place and at the time of Doctor Boynton's visit all but eleven had died and of these one was sick. He was emaciated, very anemic in appearance, stood in the sun with his back arched and head down, and had a slight diarrhea and possessed very little life, moving with difficulty when urged. The caretaker stated that this was the general appearance of a greater percentage of those which had died.

This animal was killed and autopsied. The blood was very anemic in appearance. There was practically no fat in the peritoneal cavity, the organs were pale, the mesenteric lymphatics were somewhat enlarged and soft, and upon section a watery serous fluid oozed from them. The fourth stomach and duodenum contained myriads of worms, red in color from imbibing the animal's blood, and small petechiae were scattered over the mucous membrane of these organs. There were a large number of worms of a different character in the caecum and colon. The enormous numbers of these intestinal parasites were undoubtedly accountable for the condition of this animal. Specimens of these worms were taken and later identified by Mr. L. D. Wharton, of the College of Medicine and Surgery, University of the Philippines.

There had been no deaths among the cattle for some time prior to Doctor Boynton's visit but two animals were very thin and the caretaker stated that they had exactly the same appearance as those which had died. For this reason one was killed and autopsied to see if the cause of the condition could be ascertained.

Upon autopsy the internal organs were anemic, the heart, kidneys, spleen, and liver being normal except for their pale appearance. Worms were found in the bronchioles of the lungs and there was a slight pneumonia in the left principal lobe. A large number of worms were found in the fourth stomach, small intestines, caecum and upper part of the colon. There was a marked catarrhal enteritis in the ileum and numerous petechiae. In many instances the worms were dislodged from the mucosa with some difficulty.

Specimens of the worms found in the various parts were preserved and later identified by Mr. Wharton.

In view of the large numbers of these intestinal parasites they were undoubtedly the direct cause of the emaciated and anemic condition of this animal.

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From the autopsies of these two animals picked out by the caretaker as identical in appearance with many of the animals which had died, it is probable that a majority of the latter were also heavily infested with intestinal parasites, and that these parasites were the direct cause of death.

It will be noted from the following table that 11 cattle died during the first storm on October 23, and 14 died during the second storm on November 3. This indicates that their vitality was so low that the animals could not withstand exposure when infested to such an extent with these intestinal parasites.

The caretaker was directed to transfer the entire herd to grazing lands on high ground, and this was done. On April 15, 1916, the Bureau of Agriculture was notified that only two of the cattle had died after being transferred to the high ground, and that the whole herd was in good condition with the exception of one animal which had not completely recovered. This fact demonstrated that the animals had become infested on the low-lying grazing grounds.

Table showing number of deaths from intestinal parasites in a herd of cattle and goats in the Province of Ambos Camarines.

Date.	Died.		Date.	Died.	
	Immunized.	Nonimmunized.[a]		Immunized.	Nonimmunized.[a]
1915.			1915.		
Mar. 16	1		Oct. 15		1
Mar. 28	1		Oct. 20		1
Apr. 17	1		Oct. 22		1
May 9	1		Oct. 23[b]	5	6
June 2	3		Nov. 3[c]	10	4
June 3	1		Dec. 3	1	
June 9	1		Dec. 4		1
Aug. 1-31	9		Dec. 7	2	1
Sept. 20		1	Dec. 8	1	
Sept. 25	2	2	Dec. 9		1
Sept. 28	2		Dec. 22		1
Oct. 7		2	Dec. 23[d]	2	
Oct. 12		1			
Oct. 13		3	Total	43	26

Total deaths, 69.

[a] The nonimmunized arrived from Masbate on September 20, 1915.

[b] First typhoon.

[c] Second typhoon.

[d] Third typhoon.

The collection of worms as made by Dr. Boynton was found to contain 8 species, 7 from the cow and 2 from the goat. One species, *Haemonchus contortus,* was found in both individuals. The species, as far as they can be identified with the limited literature at hand, are as follows:

NEMATODES.

Family Strongylidæ.

Bunostomum phlebotomum (Railliet, 1902). (Synonyms: *Strongylus radiatus, Dochmius radiatus, Uncinaria radiata, Monodontus phlebotomus*).—These are small white worms with a large armed buccal capsule, bent dorsally. There is a short dorsal buccal tooth, a pair of ventral buccal teeth, and a pair of small subventral lancets all attached to the base of the capsule. There are six circumoral papilæ and a pair of short blunt cervical papillæ opposite the anterior portion of the oesophagus. The oesophagus is enlarged at the posterior end.

The males are 10 to 14 millimeters long and about 0.5 millimeter in thickness. The dorsal lobe of the bursa copulatrix is shorter than the lateral lobes. The dorsal ray is asymmetrical, coming off from the base of the left lateral ray and giving off the externolaterals asymmetrically. The spicules are long and filiform.

The females are 15 to 20 millimeters in length and a little thicker than the males. The posterior end of the body is attenuated and terminates in a slender, bluntly pointed tail behind the anus. The vulva is situated a little in front of the middle of of the body.

The above were collected from the ileum and fourth stomach of a cow (*Bos taurus*) at Minalabag, Camarines, and are listed as specimen No. 110, Helminthological Collection, College of Medicine and Surgery.

Oesophagostomum columbianum (Curtice, 1890).—This is the common *Oesophagostomum* of sheep and goats. It undergoes its development in nodules in the walls of the intestines and leaves these nodules only when it has reached the adult stage at which time it passes into the lumen of the intestine where copulation and egg-laying occurs.

The mouth is surrounded by a slightly inflated mouth collar. There are well developed lateral membranes extending from the transverse groove posteriorly along the whole length of the body. A pair of cervical papillæ are present in front of the middle of the oesophagus.

The males are 10 to 16 millimeters long and have a bursa. The females are 14 to 20 millimeters long with the vulva close to the end of the tail.

The above were collected from the intestine of a goat at Minalabag, Camarines, and are listed as specimen No. 106, Helminthological Collection, College of Medicine and Surgery.

Oesophagostomum sp.—A number of worms of this genus were also collected from the cow. While they more closely resemble *O. radiatum* than any other described form, it is believed that they should be placed in a separate species. The mouth collar is more prominent than in *O. radiatum*, the cervical inflation of the cuticle is very pronounced, and the body is slightly larger than that of *O. radiatum*. The externo-dorsal rays of the bursa of the males originate very close to the root of the dorsal ray and the external divisions of the dorsal ray are knob-shaped while the internal divisions are very long and slender.

The above were collected from the caecum of a cow, at Minalabag, Camarines, and are listed as Specimen No. 104, Helminthological Collection, College of Medicine and Surgery.

Family Trichostrongylidæ.

Haemonchus contortus (Rudolphi, 1803) Cobb. 1898. (Synonym—*Strongylus contortus*).—This is the common "Wire worm" of cattle, sheep, and goats. The head is small and bears a minute buccal lancet. There are two cervical spines about 0.3 to 0.4 millimeter from the anterior end of the body. The oesophagus is claviform. The body is long and slender and attenuated toward both ends.

These worms were found in the fourth stomach of both the goat and the cow at Minalabag, Camarines, and are listed as specimens Nos. 102 and 108, Helminthological Collection, College of Medicine and Surgery.

Family Trichinellidæ.

Trichuris ovis (Abildgaard, 1795) Smith 1908. (Synonym—*Trichocephalus affinis*).—This is the common whip worm of cattle and sheep. They measure from 45 to 70 millimeters in length, the anterior slender portion of the body making up about two-thirds to three-fourths of the whole length.

The posterior end of the male is curved spirally and bears a single spicule surrounded by a spiny sheath with a bulbous enlargement at the end. The posterior end of the female is straight and is filled with lemon-shaped eggs.

These were collected from the caecum of a cow at Minalabag, Camarines, and are listed as specimen No. 103, Helminthological Collection, College of Medicine and Surgery.

Family Filariidæ.

Filaria labiato-papillosa.—These are long, slender, thread-like, white worms with a terminal mouth surrounded by a chitinous ring bearing two papilla-like processes.

The males are 4 centimeters long with a spiral pointed tail bearing 4 pairs of pre-anal and 5 post-anal papillæ, and two unequal spicules.

The females are 6 to 7 centimeters long. The posterior end is slightly curved and terminates in a fasciculus of small blunt points preceeded by two thick, cortical, lateral papillæ.

These worms were found free in the abdominal cavity and in the lungs of a cow, Minalabag, Camarines, and are listed as specimen No. 114, Helminthological Collection, College of Medicine and Surgery.

Nematode sp.—Several female worms 30 to 35 millimeters in length and having a diameter of about 0.6 millimeter were collected from the fourth stomach of the cow. They probably belong to the family Trichostrongylidæ although they could not be identified further. They are filled with large thin-shelled eggs averaging 107 microns in length by 44 microns in diameter. The vulva is situated about 1 millimeter in front of the anus and the tail is short and sharply pointed behind the anus. They are listed as specimen No. 115, Helminthological Collection, College of Medicine and Surgery.

TREMATODES.

Paramphistomum sp.—A single small specimen of this genus was found in the stomach of the cow.

It is immature and so the species could not be determined. It is listed as specimen No. 112, Helminthological Collection, College of Medicine and Surgery.

A NEW TENT-FRAME FOR PLANT FUMIGATION.

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

Some years ago while in charge of the Subtropical Garden of the Bureau of Plant Industry, United States Department of

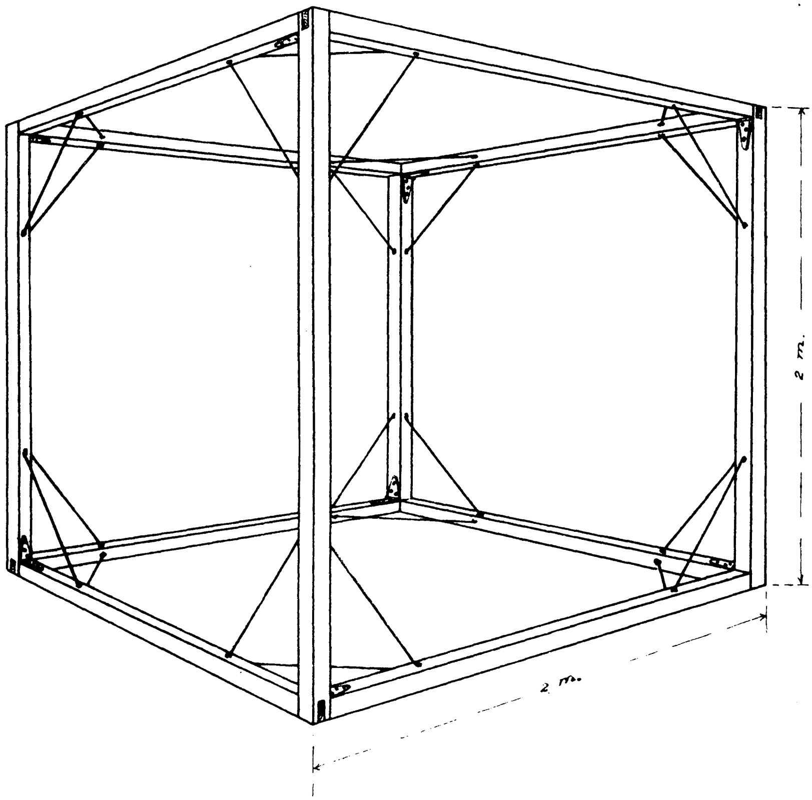

FIG. 1. Frame erected, ready for the tent cover.

Agriculture, at Miami, Florida, the writer had occasion to fumigate a comparatively large number of small mango trees in the field. In plant fumigation, in the case of large trees, the trees themselves form the support for the fumigation tents, obviating the need of a supporting frame, but in this instance the trees were too small to make this feasible, and at first ordinary fumigating frames used for such purposes were employed. These frames served very well when the number of trees to be treated was limited, but in large practice it was soon found that

too much time was lost in setting up and taking down the frames to make them practical for general use.

The writer then sought to devise a frame that would be of light weight, yet have the necessary rigidity, and the setting up and taking down of which would require a minimum amount of time, and which, when folded, would take up a minimum amount of space. After some experimenting, the frame hereinafter described and illustrated was evolved and found to meet the demand very satisfactorily.

The wood used in the construction of this frame should be light

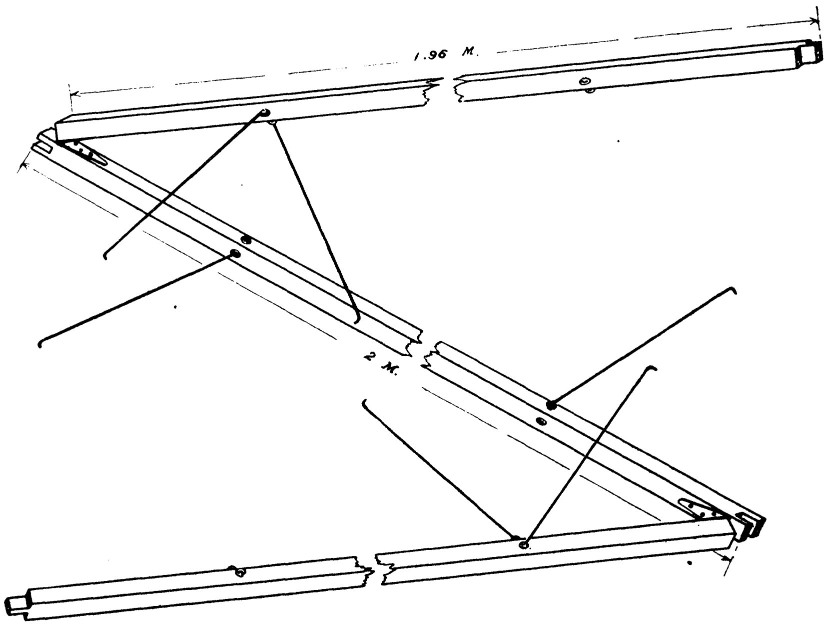

FIG. 2. Section of frame partly folded.

and strong, but not liable to warp. Finished lumber, 4 by 4 centimeters, has been found to be of the most convenient dimensions. The frame may be made of any size desired, and square or rectangular in shape.

The accompanying line drawings illustrate a cubic frame with outside measurements of 2 meters and a content of 8 cubic meters. When knocked down, this frame consists of four separate sections that fold together (figs. 1, 2, 3, and 4), that are interchangeable, and that are each an exact counterpart of the others. The practicability of this frame and the rapidity with which it may be erected are based entirely upon the fact that all sections *duplicate each other perfectly.*

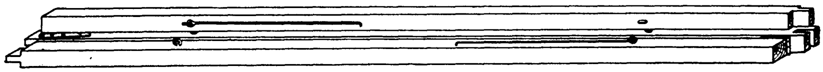

FIG. 3. Section of frame, folded.

The materials required to make the frame are as follows:

4 pieces finished lumber, 4 by 4 centimeters by 2 meters, the opposite ends of each piece being cut in mortises at *right angles to each other* and 4 centimeters deep.
8 pieces finished lumber, 4 by 4 centimeters by 1.96 meters, one end of each being shaped into a tenon 4 centimeters long.
24 hooks, 55 centimeters long, made of iron wire, 4 or 5 millimeters in diameter.
48 screw eyes or staples.
8 hinges, 10 centimeters long, and screws.

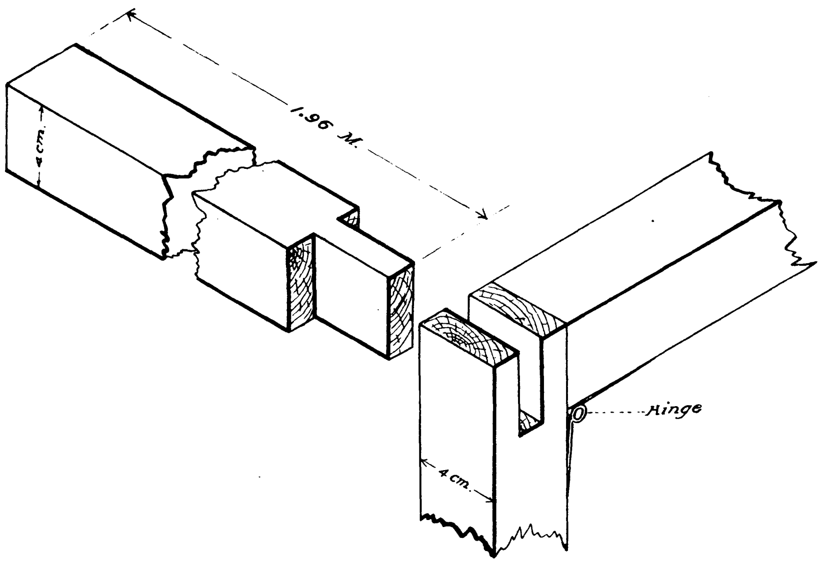

FIG. 4. Corner detail of frame.

These materials should be joined into four separate sections as shown in figs. 1, 2, and 3. If the carpentry work has been carefully done and the hooks attached properly, all joints will be interchangeable and, after a little practice, the frame may be erected in less than five minutes.

If it is desired to make a frame that is higher than it is wide, say 2 meters high and 1.5 meters wide each way, make the 8 pieces with the tenon 1.46 meters long, all other parts being as previously described.

In order to preserve the wood from decay and from the attacks of termites, it is well to paint it thoroughly with carbolineun.

CURRENT NOTES—FOURTH QUARTER.

NOTES BY CLEVE. W. HINES, Sugar Technologist.

SUGAR CANE IN THE ISABELA DISTRICT OF THE ISLAND OF NEGROS.

Plans were made and money appropriated for a large Government central sugar factory in the Isabela district of the Island of Negros during the past year, but on account of the advance in the prices of machinery and all other supplies, as well as the difficulty of transporting this material because of the lack of steamers, the project was temporarily abandoned until more normal conditions should prevail. In the meantime the Bureau of Agriculture has taken steps to secure all the data possible on the cane now grown in that district and has established a sugar laboratory there to carry on this work.

Negros purple (Morada), a soft cane of a dark-purple color, is grown almost exclusively in that region.

The results of analyses were as follows:

Month.	Cane.		Juice.[a]		
	Sucrose.	Fiber.	Total solid.	Sucrose.	Glucose.
February	12.7	10.2	18.20	15.74	0.50
March	13.4	10.4	20.09	17.63	.58
April	13.5	10.3	19.54	17.17	.41
May	11.5	11.0	18.59	15.51	.43

[a] Extraction 95.5 per cent.

It was found that plant cane averages approximately 80 tons per hectare and that the better lands ratoon successfully for as many as six crops.

BACTERIATED PEAT.

A new plant food with a promising future is expected to result from the experiments conducted by Professor Bottomley on certain classes of peat. It has been found that by properly treating this peat with bacteria the amount of soluble humates is largely increased. These bacteria, after completing their work, are largely destroyed by heat and are then replaced by the Azotabacter bacteria which cause the fixation of nitrogen in the fertilizer and thus make it available to plants.

HILLING UP CANE ROWS.

Results of work done in the Philippines during the past three years indicate that hilling up of sugar cane is a good practice only on certain classes of soils. Where the soils are heavy and underlaid with an impervious substratum and especially where the land is quite low and level the practice is a very good one. The best results were obtained by having the individual cane rows drain into a blind ditch or against a small dike at the end of the field which was placed at right angles to the cane rows and parallel with the main drainage canal. The drainage waters, which carry more or less material including much plant-food substance, are thus checked in their course and made to deposit this material in the shallow ditch or against the dike of earth. The water afterwards reaches the main drainage canal by seepage when there is but a small amount present or, in case the ditch is filled by heavy rains, by overflow from along the sides of the small ditch or over the dike.

BEET-SEED SUPPLY OF THE UNITED STATES.

At the beginning of the great war in Europe the United States required 12 million pounds of beet seed annually for planting.

Practically all of this seed came from Germany and Austria. On account of the effective blockade of those two countries by the allied powers it became almost impossible to ship any of this seed to America. An agreement was then reached with the allied powers to permit 15 million pounds of the seed to be shipped to America with the express proviso that the U. S. Department of Agriculture be the sole distributor and that none of this seed be planted on foreign soil.

Yet this importation did not nearly fill the requirements as more seed was required for the plantings than ever before. It was estimated that 14 million pounds would be planted for the 1916 crop if seed could be secured. The price of beet seed in the United States then rose to $25 per bag, or 25 cents gold per pound, which is higher than it was ever known before.

This state of affairs caused a new industry to be started in the state of Utah where experiments had been conducted for a number of years, and now some of the very finest beet seed is produced there commercially.

It is anticipated that within a very short time the United States will be entirely independent of other countries for its beet-seed supply.

LARGE SUGAR CAMPAIGN.

The Calamba Sugar Estate, Laguna, P. I., with a daily capacity of 1,200 tons of cane, has experienced a very successful campaign and plans are being made to extend the milling capacity to 2,000 tons of cane per day during the coming year. The production for the past campaign was approximately 15,000 tons of test sugar.

AERATION OF THE SOIL.

The proper aeration of the soil for sugar cane has formed one of the best means of increasing tonnage in this Archipelago barring the application of fertilizers and irrigation water.

The method practised in previous years was entremely shallow plowing with no attempt to disturb the subsoil. This system caused the upper layer of soil to become so completely exhausted of its plant-food material that the land was gradually diminishing in production year by year. The application of this modern system has greatly increased the yields and has given extremely encouraging results in general. By this system the rootlets are assisted in reaching a new source of plant-food material, drainage and capillarity are greatly improved, and above all the soil is more properly aerated which offers great assistance to the bacterial activities of the soil.

DETERIORATION OF CUT SUGAR CANE.

Extensive experiments were conducted the past year by the Bureau of Agriculture in order to determine the rapidity with which cane will deteriorate after being cut and the factors which influence this change. It was proved that this change in composition depends upon a great number of factors, one of very great importance being cane variety. The softer varieties of cane such as Luzon white, Negros purple, and Manila black, suffered the greatest deterioration while the harder foreign varieties and one of the so-called Inalmon native varieties suffered the least. On cloudy days following showers and on cloudy days during light showers the deteriorations was least, and on clear sunshiny days when the dry cane was left uncovered and entirely exposed to the sun the deterioration was greatest.

During the first twenty-four hours after being cut, cane suffered but little, but after that time the rate of change rapidly increased until at the end of five days the very best cane had usually suffered so badly that it was useless for milling pur-

poses. This rate of change after the first twenty-four hours was in no wise constant even for the same variety of cane, but was determined largely by climatic conditions.

ARTICLES ON WHITE-SUGAR MANUFACTURE.

A very instructive series of articles on the subject of plantation white-sugar manufacture written by Dr. Charles E. Coates, dean of the Audubon Sugar School of Baton Rouge, Louisiana, has recently appeared in the columns of the Louisiana Planter. Doctor Coates emphasizes the necessity of chemical control of every part of the work, cleanliness throughout the different processes, and above all the most rigid clarification of the liquors.

DETERIORATION OF SUGAR.

A fact well known to sugar technologists is that the keeping quality of sugars is dependent upon the moisture content of the sugar as well as quantity and character of the nonsugars present, but primarily upon the former since the moisture content of any grade of sugar may be sufficiently reduced to prevent bacterial deterioration of that sugar.

The Colonial Refining Company of Australia have arrived at the factor $\frac{W}{100 - P\ .333}$ (W = water, P = polarization) as giving very nearly the safety margin for the sugars stored in the country. Prof. W. L. Owen of the Louisiana Sugar Experiment Station found that this factor held also very well for the sugars of Louisiana. A similar series of experiments are being carried on by this Bureau using various classes of sugars of the Philippines in order to determine the proper formula to use here.

QUARANTINE AGAINST IMPORTATION OF SUGAR CANE.

There is a very rigid quarantine against the importation of sugar cane into the United States. This not only applies to the complete cane to be used for commercial purposes but also to cuttings, seed, etc. This quarantine was prompted by the fungous diseases affecting the sugar cane in the Fiji Islands and several other localities where much damage was done to the sugar industry in the countries already affected.

For years the three varieties of sugar cane, striped, purple, and white, were planted exclusively in the State of Louisiana. Later on, seedling varieties were produced in various tropical countries

and were gradually tested in the subtropical region of that state. From these introductions the two Demerara seedling varieties Nos. 74 and 95 resulted which largely replaced the three previously grown. Under the present quarantine, the work of importing varieties of cane by private individuals and corporations will be effectively checked, but it is hoped that this valuable work will go on steadily under the auspices of the U. S. Department of Agriculture.

In these Islands there is also a rigid quarantine against the importation of sugar cane but this restricts only to the extent of requiring that all importations of sugar cane be made through the Bureau of Agriculture so that cane may be inspected and thoroughly disinfected before it is allowed to reach the importers.

NEW SUGAR REFINERY FOR BOSTON.

A new sugar refinery is to be built at Boston with a yearly capacity of one million barrels of refined sugar.

The promoters of this enterprise are the United Fruit Company and the Nipa Bay Company, each to control one-half interest in the corporation. The total cost of the new refinery will amount to upward of 2½ millions of dollars.

"UBA" CANE FOR FORAGE.

Uba cane has been used with very satisfactory results as a forage crop for all classes of animals at the experiment stations of the Bureau of Agriculture in the Philippines during the past four years. Such a great demand has been created for this forage plant that upward of 100,000 points were distributed to the different plantations during the past year.

This is a yellow variety of cane containing from 14 to 16 per cent of fiber and produces as high as 10 per cent of sucrose when mature. It grows slender and quite erect and has narrow drooping leaves.

The cane yields best on lands which may be irrigated. It is planted in rows one meter apart and spaced three points to the meter. When the cane reaches the age of six months the first harvest is usually made. Subsequent harvests of the ratoon cane are made every three to five months during which time cultivation is given and irrigation water applied. This cane is harvested for use as forage while yet green or immature, and produces upwards of one hundred tons of excellent forage per hectare.

NEW SEEDLING VARIETIES OF SUGAR CANE.

The majority of the cane planted in the Philippine Islands is known as "native varieties" since this class of cane has been cultivated here from time immemorial.

Upon the introduction of the varieties cultivated in Hawaii, Louisiana, Java, and other countries it was found that much larger yields resulted from many of these varieties.

It was thought that even better varieties might be produced from seedlings here and consequently the Bureau of Agriculture took up this work of plant breeding and the propagation of new seedling varieties two years ago with the result that entirely new varieties have been developed. It will be some time, however, before sufficient chemical analyses of these different varieties may be made and the results of the work ascertained.

In addition to the native varieties the following foreign varieties were used in this work: Yellow Caledonia, Rose bamboo, Louisiana striped, Demerara 1135, and Hawaii Nos. 16, 20, 27, 69, 227, 309. It was found that during the past year, the seed from Louisiana striped and Hawaii Nos. 20 and 227 gave the best germination, while the seed from the native varieties gave the poorest.

NEW CANE-JUICE CLARIFIER.

A new clarifying reagent known as "sanso clarifier" was received late in the grinding season and distributed to various mills yet in operation. It has not been possible to secure data from the planters on the results of this reagent but it is thought that good results will be attained where plantation-white or yellow-clarified sugar is made. The sample received by this Bureau contained 39 per cent P_2O_5 with a part of the phosphorous in the form of a dicalcium and tricalcium phosphate and 1.58 per cent $CaSO_4$ (calcium sulphate).

INTRODUCTION OF CANE FROM JAVA.

In October, 1915, the following varieties of sugar cane were received from the Java Experiment Station: Java 100, 213, 247, 826, 979, and Black cheribon.

Unfortunately this shipment was so long in transit that the cane had badly deteriorated and it was possible to save only two varieties, No. 213 and Black cheribon. These two varieties have made an extremely good growth and will furnish sufficient material for a limited number of chemical tests during the next maturing season.

A second shipment was received in September of the present year consisting of the following varieties: B. 247; E. K. 2; D. 152; Black cheribon; 100 P. O. J.; 213 P. O. J.; 826 P. O. J.; 979 P. O. J.; 1499 P. O. J.; 1507 P. O. J.; and 2542 P. O. J.

This shipment arrived in excellent condition and hope is entertained that some of the new varieties will prove as successful here as they have been in Java.

DISPOSITION OF CANE TRASH.

In previous years it was the universal custom to burn off the cane leaves and trash immediately after the cane was harvested. This had the effect of depriving the land of the much-needed organic matter—nitrogen contained in this substance—as well as the loss of a certain amount of moisture from the earth caused by the heat of combustion. There is now a growing tendency to space the cane rows wider apart and whenever possible plow under this material. It has been proved that in seasons when there is a limited amount of rainfall a better crop of ratoon cane will result by the latter treatment by reason of the moisture-holding quality of this mulch and the preservation of the nitrogen which would have been lost by the burning process.

NEW JUICE-SETTLING TANK.

A new juice-settling tank has been invented and recently placed on the market by Messrs. Corne and Burquieres of New Orleans, Louisiana.

Extensive tests have been made with this settling outfit in Louisiana and it is claimed that better results have been attained than with any of the aparatus previously used for that purpose.

This is a continuous settling method in which the untreated juice is continually entering and the treated juice continually leaving, there thus being less juice in process than is possible with many of the previous apparatus.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao Experiment Station.

ANALYSES OF TWO PHILIPPINE STARCH PLANTS

The Oroy, *Amorphophallus campanulatus,* and the Palauan, *Cyrtosperma merkusii* are two endogens, native to the Philippines—the first with large fleshy, flat corms, the second with large rootstocks—which are utilized to some extent as a source of starch in times of scarcity of food. At the request of the writer, the above plants were recently analyzed for their food

value by Dr. H. C. Brill of the Bureau of Science, with the following results:

Contents.	Oroy.	Palauan.
	Per cent.	*Per cent.*
Moisture	77.83	65.18
Protein	1.40	
Starch	12.67	7.59
Fat	0.13	0.47
Ash	1.34	
Undetermined	6.63	

It is thus evident that the starch-carrying parts of these plants have a very small starch content with a correspondingly low food value. The utilization of either of these plants for starch or other food purposes would therefore not be profitable in comparison with other plants such as the cassava, yam, and tongo. Both the oroy and the palauan are striking ornamentals and well worthy of culture in a garden or in the conservatory.

PLANT-INTRODUCTION NOTES.

Plant introduction in the Philippines does not mean simply the bringing into the Archipelago of exotics; frequently it is the introduction of a plant from one part of the Islands where it has grown for centuries to another locality within a day's travel where it is totally unknown, and there is often considerable difficulty in getting in touch with men who are sufficiently interested in new and untried plants to give immigrants the proper care until they are well established.

The cherimoya was one of the fruits which the writer first assisted in introducing, and owing to the fact that the most favorable localities for these plants are distant from Manila and quite inaccessible, there was much fear that the plants would perish before they could arrive at their destination or before they could become established. The writer was therefore much gratified during a recent trip through the Mountain Province in northern Luzon to find quite a number of cherimoya plants in thriving condition at various altitudes up to 1,800 meters, due to the efficient coöperation of Mr. H. Sandkhul, formerly of the Bureau of Forestry, and Mr. Juan Gaerlan, agricultural inspector in charge of Lepanto subprovince.

Probably no one has rendered such important service to his district in this respect as Mr. W. B. Beard, Division Superintendent of Schools, Sorsogon.

The writer had the pleasure of meeting Mr. Beard in Sorsogon about 18 months ago, which resulted in a coöperative agreement, Mr. Beard receiving from the Bureau of Agriculture plants of

more than thirty species of tropical fruits, nearly all of which are new or rare to that province. This collection, among other plants, includes such fruits as the mangosteen, bauno, marang, avocado, durian, and biriba, a number of panama-hat palms, and robusta coffee.

Part of the provincial school garden in Sorsogon is now occupied as a variety fruit orchard of these trees, and a large shipment of plants was recently sent to Mr. Beard for distribution to the schools in the various municipalities of the Province of Sorsogon. These school gardens will serve both to give practical education in fruit growing to the pupils and in due time as local nuclei for plant-distribution work.

POLLINATION OF THE NIPA PALM.

The flowers of the nipa palm, *Nypa fructicans*, omit a fetid odor that is noticeable for some distance, and which attracts swarms of small flies and bees that evidently convey the pollen from the male to the female flowers. Specimens of these insects were collected and sent to Mr. A. L. Quaintance, entomologist in charge of deciduous fruit investigations, Bureau of Entomology, U. S. Department of Agriculture, who communicates to the writer that the flies have been identified as *Drosophila hypocausta* O. S., and *Drosophila* sp., near *pumilio* De Meij. The *Hymenopter* was found to be a species of *Trigona.*

TOP WORKING AVOCADOS.

The Florida Grower recently contained an article on the top working of avocados as practised by Mr. W. J. Krome, in Medora Grove, Homestead, Florida, which is of timely interest, the method described being cleft grafting.

According to Mr. Krome, the operation may be performed from the early part of November to the end of February though the best results have been obtained during the latter part of November and the first half of December. Older trees may be top-worked, but the results are most satisfactory when the seedlings are 3 to 5 years old. Performed as described below, the work during the past season yielded 85 per cent of successful grafts, the stocks ranging from 4 to 12 years of age with trunks more than 20 centimeters in diameter at the point of grafting.

In order to stimulate the flow of sap it is considered of advantage to fertilize the tree with a mixture containing a fair amount of nitrate of soda about a week in advance of the date when the grafting operation is to be performed. The main trunk (or trunks if there are more than one) is then sawed off

from 30 to 90 centimeters above the ground, all limbs on the stump being allowed to remain. Owing to the fact that the wood of the avocado does not split well it is best to make the vertical cleft about 12 centimeters long in the stump with a saw instead of a grafting tool. A wedge is now driven into the center of the cleft sufficiently deep to open the cleft so that the edges may be smoothed with a knife. This should be done very carefully so that the stock and scion make a snug fit at the point of contact, for upon this depends largely the success of the operation. Then remove the wedge and insert one made of "green" wood, say of the tree just cut down. The scions should of course be taken from trees with a good performance record and should be cut from the second or third growth from the last "flush", with dormant buds and preferably from dormant trees. Scions having several blind buds should be discarded. The scions should be from 17 to 22 centimeters long, the lower part cut into a long, tapering wedge that will extend nearly to the bottom of the cut, leaving 7.5 to 12 centimeters of the scion extending above the stump. Two scions should be inserted at each end of the cleft. After the scions are inserted the wedge in the center of the cleft should be moved to and fro until it is withdrawn sufficiently to allow stock and scion to come in perfect contact, but not so much that the latter is crushed or bruised by the pressure from the cleft in the stock, after which the wedge should be sawn off smoothly, even with the stump. All wounds should be hermetically sealed with grafting wax to exclude the entrance of water and to prevent evaporation from the stock and scion, after which the top of the stump and the cleft are carefully wrapped with grafting tape. Finally the upper part of the stock should be wrapped in heavy Manila paper or light card-board so as to form as a loose cylinder around the union, and extending about 10 centimeters or more above the top of the scions. This cylinder should be filled with clean, dry sand up to within about 2.5 centimeters of the top of the scions. The sand will protect the scions from drying out and the upper part of the paper cylinder will shade them. Ordinarily the grafts will begin growing in the course of two to three weeks, though sometimes four to six weeks elapse before the buds start to grow. Where union fails to take place the young growths of the stump may be shield budded.[1]

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[1] For a full description of shield budding of the avocado, see this REVIEW, Vol. IV, No. 11, page 599, and also Bureau of Agriculture Bulletin No. 32, Plant Propagation in the Tropics.

The dead, exposed wood of the stock should be kept carefully waxed in order to keep out decay until the wound is entirely healed. This will require a period of from one to four years, depending upon the size of the stock when the grafting is performed.

Avocado trees thus top worked have in many instances bloomed and fruited during the next year and a large percentage have fruited heavily the second year after the grafting operation.

The above method of top working avocados is well worth trying with other tropical fruit trees, the grafting of which is desired.

NOTE BY J. T. ZIMMER, Assistant Entomologist.

RECURRENCE OF A COCONUT PEST.

In June, 1916, a report was received at the Bureau of Agriculture of the outbreak of some pest on coconut trees in the Province of Zamboanga, Department of Mindanao and Sulu, which was accompanied by specimens of the pest in question. According to the account the affected trees were damaged to the extent of losing much of their foliage and part of the crop of immature nuts.

The specimens inclosed were identified as the Coconut Whitefly, *Aleurodicus destructor* Quaintance, a Homopterous insect resembling in its immature forms some of the mealy-bugs, but belonging to a separate family easily distinguished from them by the alation of both sexes instead of the males only and by the presence of four wings instead of two.

This pest is of rather uncommon occurrence or at least has been recorded but few times as a serious pest. So far as known it is confined to the Philippine Islands where the type specimens were taken in 1911 during an outbreak in Oriental Negros. This, the first record of the pest, was written up and published in this REVIEW for March, 1912, Vol. V, No. 3, where the insect is described and figured. Two years after this outbreak, in 1913, a second occurrence was noted in Misamis Province, the present advent being the third.

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